ON THE COVER

BACK in 1845, John A. Roebling built his first suspension bridge and thereby gained world-wide fame. It was the Brooklyn Bridge, which was completed after his death by his son Washington Roebling. Ever since then, the firm founded by the elder Roebling has been associated with the fascinating art of spinning cables for these graceful waterway crossings. Our cover picture shows Roebling forces setting the stage for this exacting operation on the new span across Puget Sound in Washington State. Two 10-foot-wide catwalks are in position just underneath the aerial paths the cables will follow. The spinning motor carriages, suspended from the overhead lines, will travel back and forth laying wires that will be gathered into 20⅛-inch cables to support the 2800-foot span.

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IN THIS ISSUE

IN its hundred years of operation, The Harrisburg Gas Company has adopted, in turn, each newly developed method for making illuminating and heating gas. For that reason its history, as set forth in our leading article, more or less epitomizes the progress of the gas industry in general.

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HIGHWAY builders in Connecticut were temporarily stumped when a sizable hill of basalt was found to lie directly in the path of the most desirable route for an important cross-state road. They solved the problem by piercing the obstruction with twin bores, which were opened to traffic on November 1. Page 305.

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THE jet pump, which is a boon to farmers and others located beyond the range of water-distribution systems, can also serve mines in various ways. Page 313.

Compressed Air Magazine

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ADVERTISING INDEX

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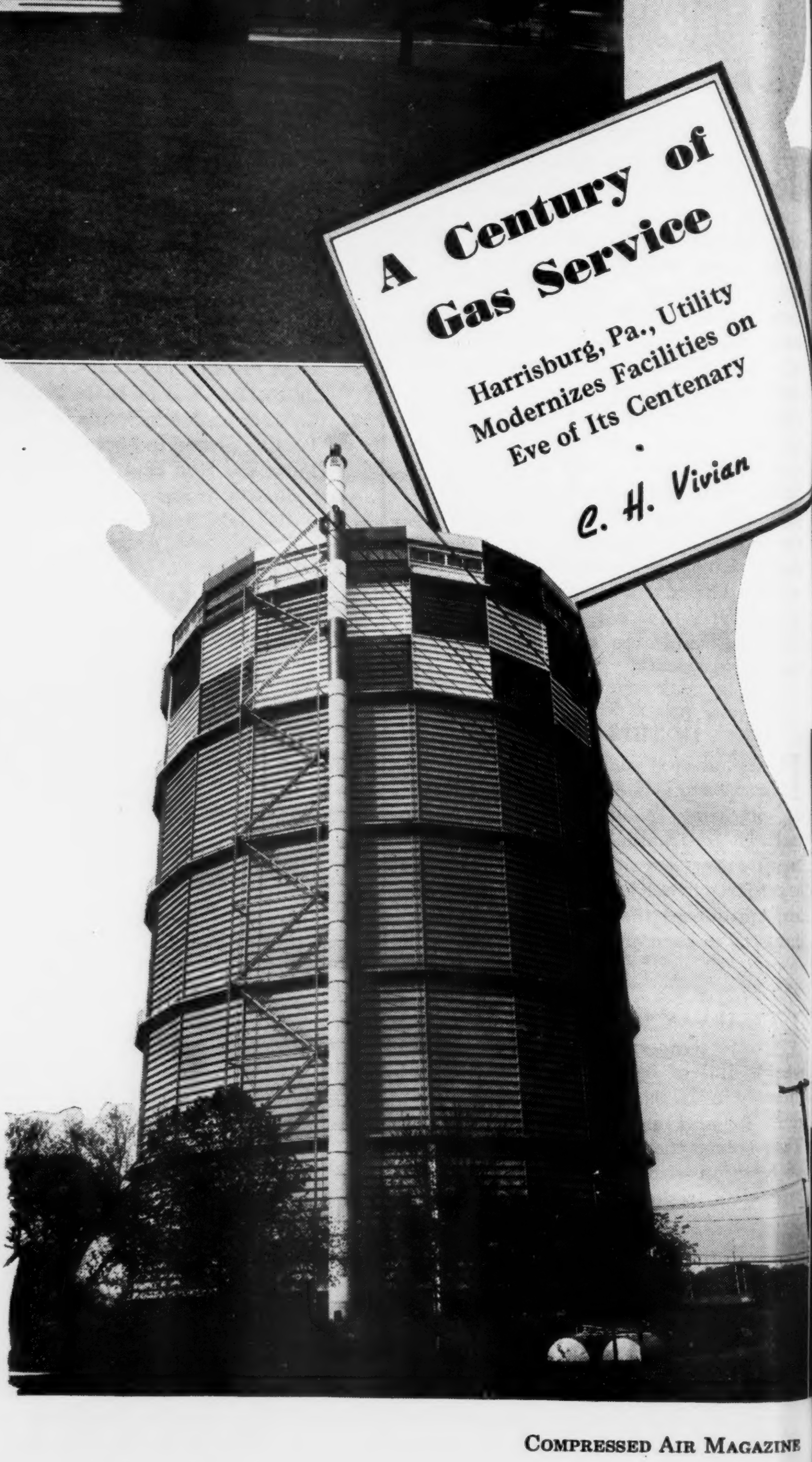
SERVICE-BUILDING ENVIRONS
Company offices are in the business section, but service and engineering departments are centered in a building at one end of an attractive and spacious area outside the city's central zone.

A Century of Gas Service

Harrisburg, Pa., Utility Modernizes Facilities on Eve of Its Centenary

C. H. Vivian

NEAR the close of the coming year, The Harrisburg Gas Company will complete a century of service to the capital city of the Commonwealth of Pennsylvania. It will pass the 100-year mark without much fuss or fanfare, because its management is more concerned with the future than the past. For the company, and the nation's gas utilities in general, the years ahead hold bright promise of continued growth. The gas industry met and survived its greatest challenge when the electric light was introduced in the 1880's, for in those days gas was used chiefly for illumination. Once it had weathered that critical period, it continued to expand with re-



GAS HOLDER AT STEELTON
This 6,000,000-cubic-foot waterless-type holder is 181 feet in diameter and 290 feet high. A service elevator runs in the exterior pipe. The upper section is checkerboarded in color to improve its visibility from airplanes. Directional arrows and letters on top can be discerned from a height of 4000 feet. Coke-oven gas received at the Steelton plant from Bethlehem Steel Company is purified by passing it through iron oxide and then stored. Pressure exerted by a floating piston in the holder discharges it as needed to compressors that increase the pressure for distribution.

newed vigor and has long since attained a secure position in our national economy.

The industry has never forgotten the lesson it learned when electricity threatened to cut off its means of livelihood. It averted that threat by teaching its customers to use gas for cooking and heating as well as lighting. Since then it has always been on the alert, seeking to widen the scope of its service wherever possible and missing no opportunity to improve and expand the manufacturing and distribution technique of the product it sells. This progressive policy has brought about significant changes in the methods and equipment employed in making gas and sending it out to consumers. The past two decades have been especially productive of new manufacturing processes, some of which are still not in widespread use.

As a result of these developments, gas plants are beginning to take on a new look. Until a few years ago, gas was made from start to final composition in relatively simple apparatus and then distributed. Recently, other methods have been added and used to supplement one another, thereby giving flexibility to the manufacturing operations and, consequently, greater assurance to customers of a continuous supply. Now, engineers have introduced some of the technique of the petroleum and chemical industries.

New, strange-looking apparatus is appearing in gas-making establishments. In it, hydrocarbons are broken up and recombined by a fascinating molecule-shuffling process. The equipment can use any one of several materials as feed stock, thus further increasing the flexibility of the means and methods of production and offering consumers still more protection against shortages or service interruptions. Because of the length of time The Harrisburg Gas Company has been operating, and the disposition of its management to keep abreast of developments, its gas-making facilities cover virtually the entire range from the oldest to the most modern.

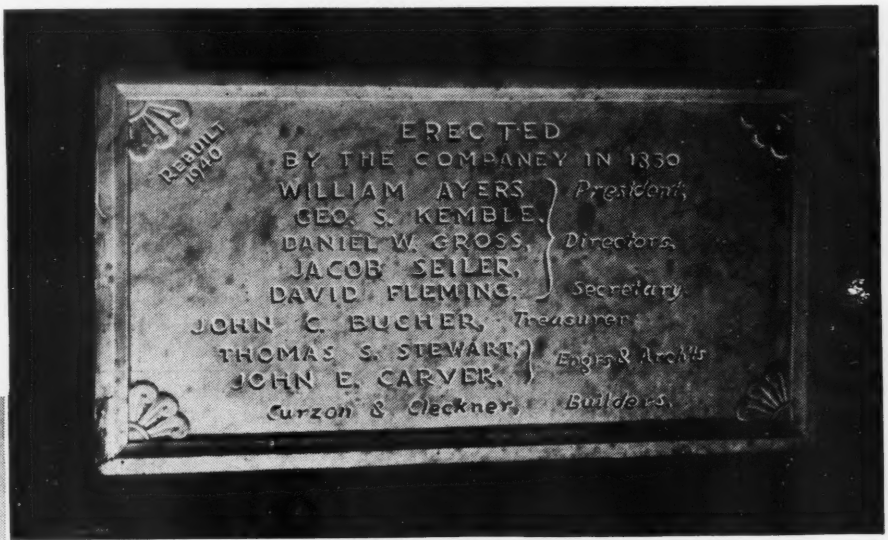
The company was organized to supply gas for lighting the Capitol and other state buildings, as well as the city streets. It was incorporated on March 28, 1848, but dissension among the promoters delayed its functioning. The first gas was not delivered to the Capitol until January, 1851. However, because most of the initial construction was completed in 1850, that year may be considered the company's beginning.

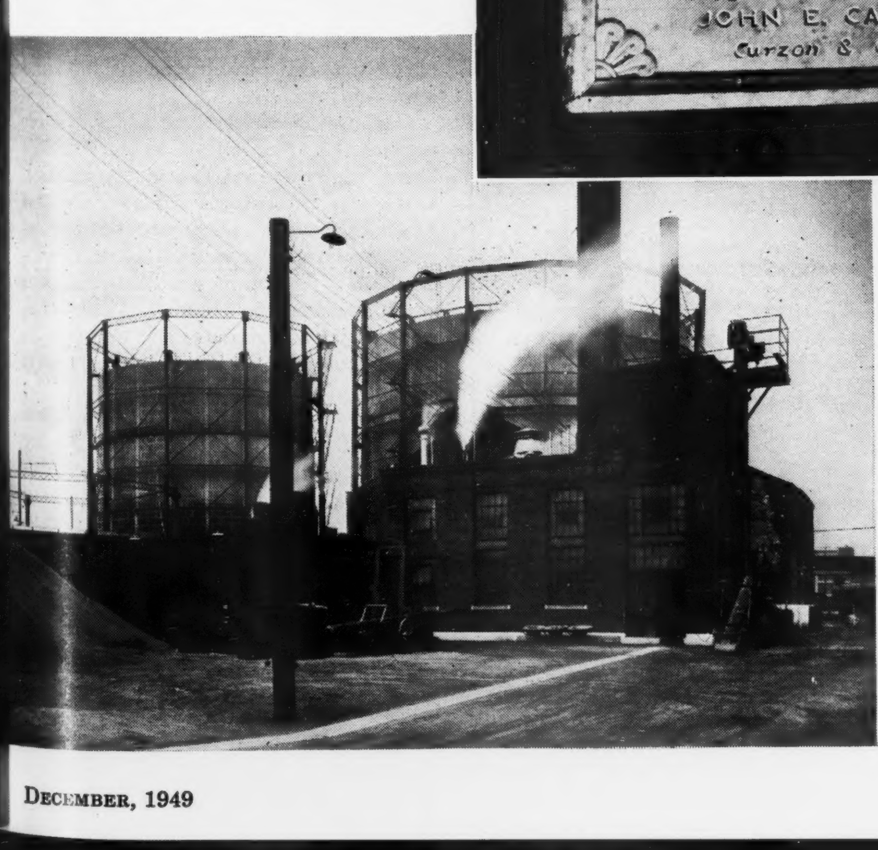
In the early days of the industry, all commercial gas was made by distilling coal. Although the process had been known and even utilized in a small way before 1804, when the first patents were obtained in England by Frederick A. Winsor, a German, the skeptical public was not ready for such an innovation and Winsor was unable to obtain a charter from Parliament for an operating company until 1812. In the meantime he had demonstrated the practicability of the new fuel by lighting Pall Mall in London in 1807. Among the objectors to his scheme was Sir Walter Scott, who wrote a friend that "There is a madman proposing to light London with—what do you think? Why, with smoke."

Thinking that the flame they saw burning traveled through the gas-distribution pipes, people feared that the latter would become overheated and set their buildings afire. When a lighting system was placed in the House of Commons, the members at first would not touch the piping without their gloves on.

HARRISBURG STATION AND HISTORICAL MARKER

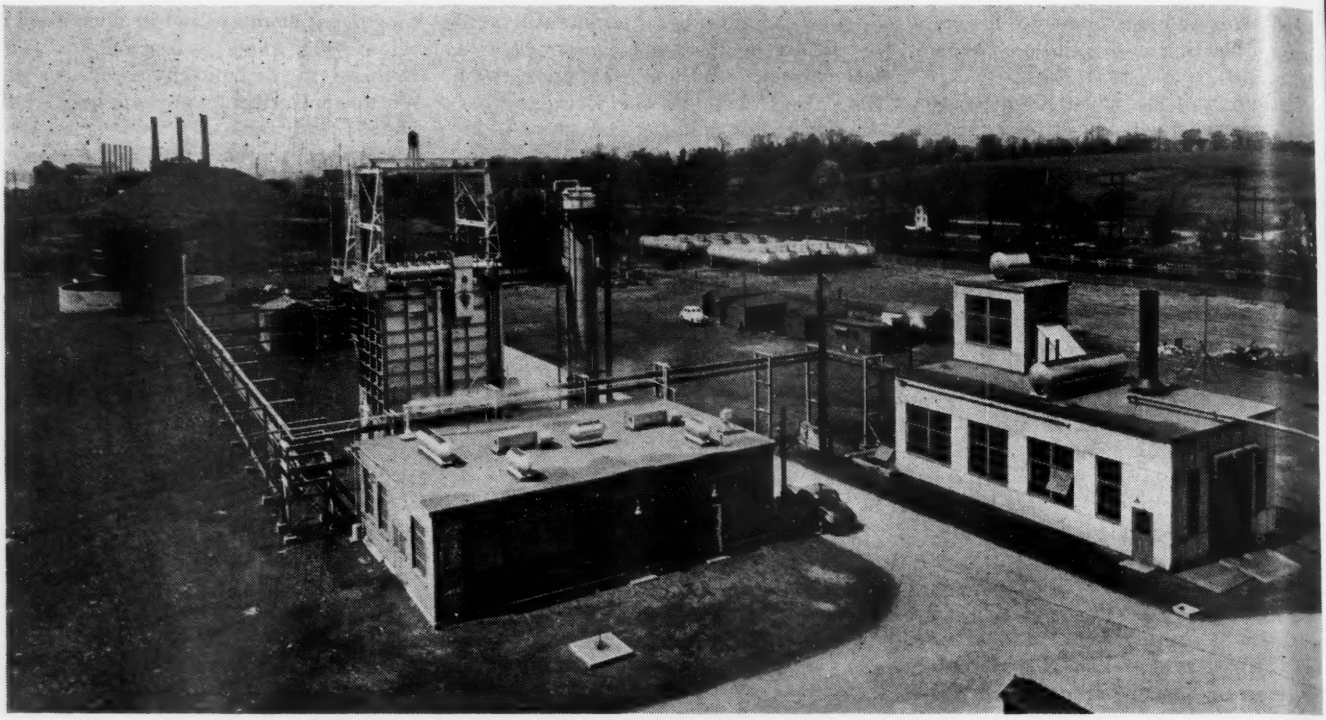
The buildings and holders shown at the bottom of the page are on the site of the original gas works. The stone tablet is a replica of one that was removed from one of the old structures and placed in an interior wall of the present booster building. Note the spelling of the word "companey" in the second line.





Londoners gazed with awe when Westminster Bridge was similarly illuminated in 1813, and it took years for them to become accustomed to the spectacle.

The idea of lighting with gas instead of the prevailing candles and the lanterns and lamps that used whale or other oil quickly bridged the Atlantic. Its feasibility was demonstrated in Philadelphia as early as 1796 by M. Ambroise & Company, described as Italian fireworkers and artists. A huge gas lamp is reported to have burned for a time atop a 40-foot tower in Richmond, Va., in 1803. It attracted much attention, but the city stuck to its oil lamps. In 1812, David Melville made gas in a limited way for lighting his home in Newport, R. I., and a small factory in nearby Pawtucket. He even induced the Govern-



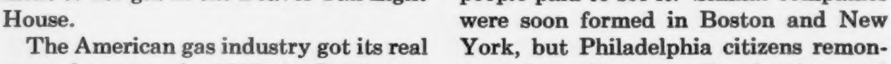
CATALYTIC GAS-CRACKING PLANT

One of the first four put in service by an American gas utility, this completely automatic plant can re-form various hydrocarbon materials into gas. The feed stock, together with steam and compressed air, is vaporized and broken up by heat in the presence of a catalyst, and the dissociated molecules are rearranged into new compounds. The cracking furnace rises just beyond the left-center building, which is the control house. The structure at the right houses a 500-hp. boiler that furnishes steam for the process. At the upper-left is a 50,000-gallon fuel-oil tank. The round black object beyond the furnace is a Hortonsphere for the storage of butane, which has thus far been used as furnace-charging stock. To the right of it are horizontal tanks for storing either butane or propane.

ment to use gas in the Beaver Tail Light House.

The American gas industry got its real start, however, in 1816, in Baltimore, Md., where the first company was organized after gas-lit Peale's Museum had created such a sensation that crowds of people paid to see it. Similar companies were soon formed in Boston and New York, but Philadelphia citizens remonstrated against gas illumination and blocked its introduction until 1836.

Service in Harrisburg was inaugurated with five benches of three distillation retorts each that initially consumed 1100 tons of coal annually. The gas was fed through 10,000 feet of piping ranging from 3 to 10 inches in diameter. The daily sales or "send out" averaged 25,000 cubic feet when the legislature was in session and from 10,000 to 15,000 cubic feet at other times. Coal gas was burned until 1882, but the record is hazy as to what steps, if any, were taken to remove impurities such as hydrogen sulphide and ammonia compounds.



AREA OF DISTRIBUTION

Gas is supplied to some 46,000 domestic and industrial customers through 400 miles of piping that ranges up to 36 inches in diameter. Approximately 88 percent of it is sold direct, and the remainder is delivered at Lebanon, 28 miles east of Harrisburg, to the Lebanon Valley Gas Company which distributes it to consumers in the surrounding area, including the chocolate-manufacturing town of Hershey. In extending its service to Carlisle, the Harrisburg company completed a new 15-mile line, 8 inches in diameter, last October.

Carburetted water gas, which was to become the principal one in the nation's cities, replaced coal gas in Harrisburg. It is made by passing steam over a bed of incandescent coal, the product of the resultant chemical reaction being a combination of carbon monoxide and hydrogen that is known as blue gas. This is enriched with vaporized oil to increase its heating value to the desired point, and it is then purified and distributed. The process was originated by Thaddeus Lowe, who became interested in gas by using it to inflate balloons. While serving during the Civil War as a Union Army aerial observer of Confederate troop movements he began experimenting with various gases, continued the work when hostilities were over, and in 1874 built the first water-gas plant at Phoenixville, Pa.

The early days of The Harrisburg Gas Company were eventful and, on occasions, troublesome. Even before oper-

ations began, it had to appeal to the state for permission to increase the contract price from \$2.50 to \$3.50 per 1000 cubic feet of gas. The rate was reduced to below \$3 in a few years, but went up to that figure again in 1863.

Lowe's introduction of water gas aroused such interest that the directors voted on June 24, 1874, to visit and inspect the establishment at Phoenixville. They evidently decided to continue supplying coal gas, but another Harrisburg group seized the opportunity to organize a competing concern. At that time franchises were not exclusive. The newcomers obtained a charter in December, 1875, constructed a water-gas plant, laid 80,000 feet of piping, and began to serve 720 customers under the name of Citizens Gas & Gaseous Fuel Company. This provoked a rate war that eventually forced the new concern to the wall. Its assets were sold by the sheriff in 1879 to satisfy a bank debt. Another local group acquired the property for \$60,000 and carried on as the Peoples Gas & Gaseous Fuel Company.

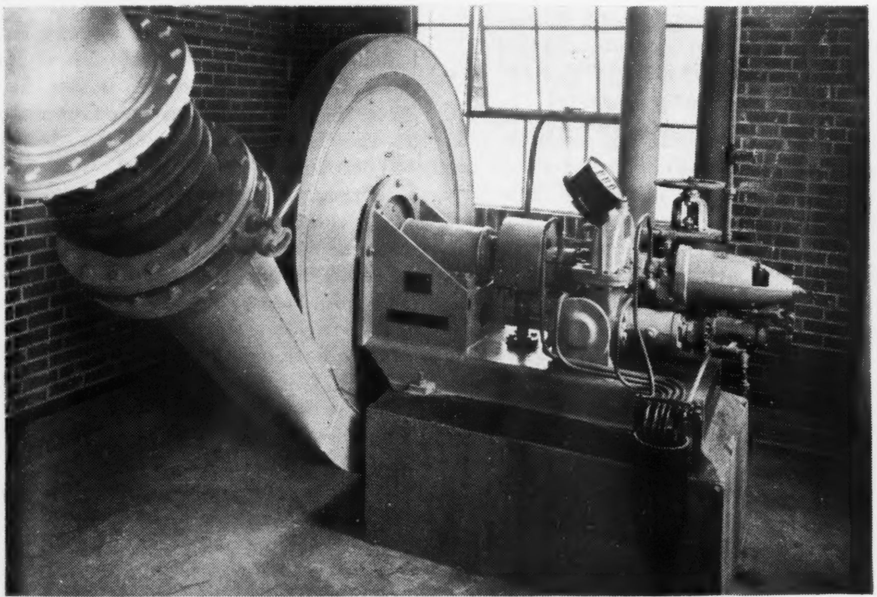
In the autumn of 1882, The United Gas Improvement Company, of Philadelphia, leased the facilities of The Harrisburg Gas Company and built a water-gas plant. In the following spring it took over the Peoples company on a similar basis and shut down its gas generators. The water-gas sets were sold to the Pennsylvania Railroad, which used them to make gas for lighting its cars. All customers of the two concerns were thereafter supplied with gas from the Harrisburg company's plant. Expansion continued through the consolidation of several smaller concerns, and in 1924 all operating properties were merged, the name of The Harrisburg Gas Company being retained.

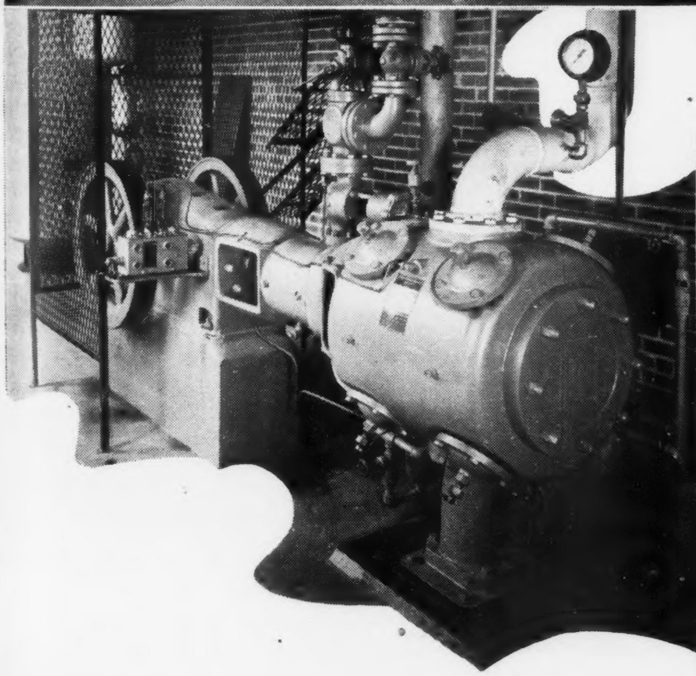
Following the custom of the times, the original plant was put up near the center of the district it was to serve. Thus situated, it could distribute gas through a minimum length of radiating lines. A central location was desirable for another reason: it permitted reaching the extremities of the system with the pressure exerted by the telescoping metal gas-storage holders. When water-gas sets were introduced, a boiler plant was provided to supply process steam. As the community grew and lengthened mains required higher send-out pressures, steam-driven compressors were put in.

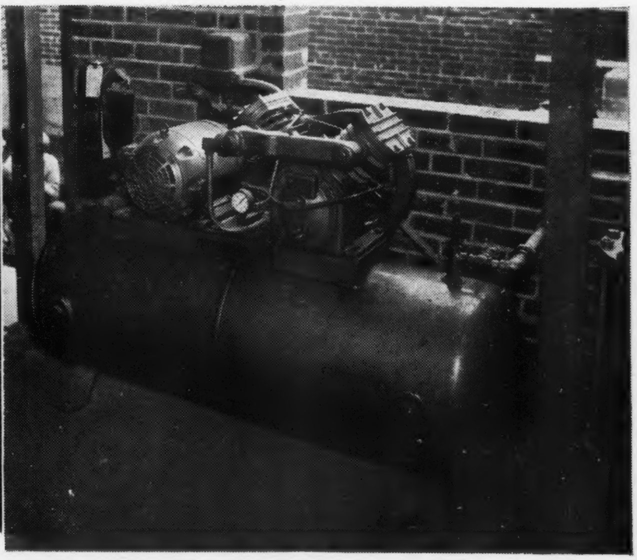
To better meet the growing demands for service, the company contracted, in 1914, to purchase coke-oven gas from the Steelton Works of the Bethlehem Steel Company located 6 miles south of Harrisburg. The gas was transmitted to the Harrisburg plant and, after being purified and enriched, sent out with the existing facilities. During the following years it was necessary to supplement the equipment at the Harrisburg station. A Type XPV steam-driven reciprocating compressor, with a capacity of 100,000 cubic feet per hour, was installed in 1920, and a similar unit delivering 150,000 cubic feet per hour in 1923. In the latter year two 250-hp. boilers were also put in. The station was again expanded in 1931-32 by adding a 300,000-cubic-feet-per-hour turboblower for pressure boosting

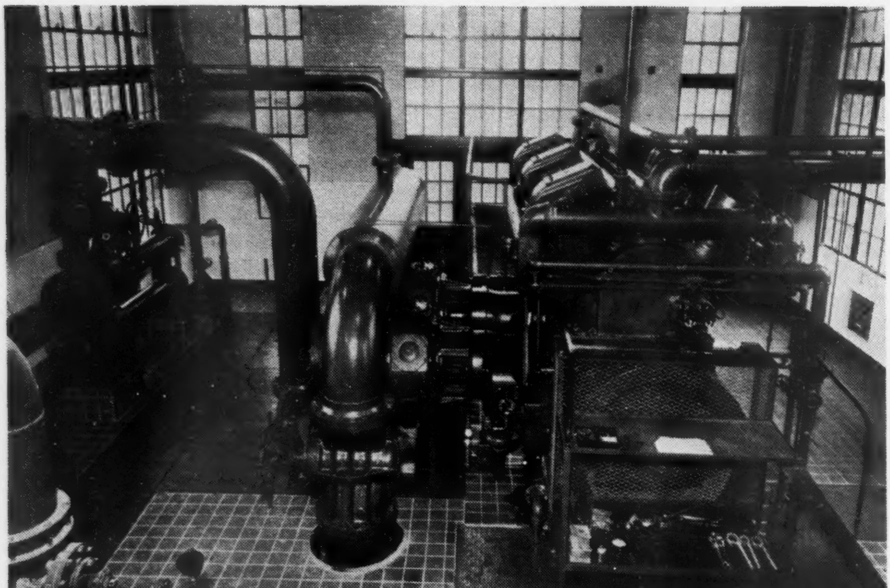
CRACKING-PLANT ACCESSORIES

Air at 20 psi. pressure is supplied to the cracking furnace by a steam-driven compressor of 277-cfm. capacity (bottom-left). Combustion air for the oil burners of the furnace comes from the Ingersoll-Rand centrifugal blower shown just below. It has a capacity of 4300 cfm. at 2 psi. pressure and is driven by a Westinghouse 60-hp. steam turbine. Air at 60 psi. pressure for operating the instruments that control the cracking process is furnished by the motor-driven machine pictured at the bottom-right. Duplicates of all these accessories have been added since the plant was built.









LATEST GAS-DISTRIBUTION COMPRESSOR

This Ingersoll-Rand Type KVG, 600-hp., gas-engine-driven machine in the Steelton station can pump 335,000 cubic feet of gas hourly at 34 psi. pressure. Against the wall at the left is an aftercooler through which the gas is passed after it has been compressed.

purposes and another XPV compressor, with a capacity of 150,000 cubic feet per hour, to take care of the increased high-pressure load. In 1924 a new handling plant was built at Steelton about midway between the source of the coke-oven gas and the Harrisburg station. Since then the Steelton establishment has been the nucleus for expansion and the Harrisburg plant has gradually become of secondary importance.

The original equipment at Steelton included a 6,000,000-cubic-foot gas holder, gas purifying and enriching apparatus, two Ingersoll-Rand Type PG gas-engine-driven compressors each with a capacity of 50,000 cubic feet per hour at 35 psi. discharge pressure, and two gas-engine-driven rotary compressors. The latter machines were installed primarily to transmit gas at pressures up to 9 psi. to low-pressure holders at the Harrisburg station that supply the high- and low-pressure distribution systems from that point. The Steelton holder, which has a movable piston instead of the telescoping sides of previously used types, had been invented in Germany a few years before its erection and was the third one of its kind to be put in service in the United States.

After coke-oven gas became the principal source of supply—the base load, in gas-plant terminology—the water-gas sets at Harrisburg were operated only during periods of peak consumption when the available coke-oven gas was insufficient to meet the demand. The facilities answered the requirements for some years, but with continued expansion it became apparent around 1940 that additional provisions would have to be made. In order to increase the delivery of gas to outlying districts, two more reciprocating compressors were installed at Steelton in 1943. These are Ingersoll-Rand Type XVG direct-connected, gas-engine-driven machines, each having a capacity of 120,000 cubic feet per hour at a discharge pressure of 35 psi.

A few years ago it was realized that the volume of gas supplied by the coke ovens would soon become inadequate for peak loads, and in 1947 equipment was set up at Steelton to supplement it, when necessary, with gas composed of either butane and air or propane and air. Butane and propane are two of the familiar "bottled" gases that are widely used in rural and outlying urban areas not served by gas-distribution systems. Also, in some towns that are too small to support gas-manufacturing establishments of the usual type the gases are mixed with air in a central plant and dispensed to consumers.

Included among the group called liquid-petroleum gases—more commonly L. P. G.—butane and propane are recovered as by-products in natural-gasoline plants and petroleum refineries. Although they are gases at normal pressure and temperature, they can be liquefied by the application of moderate pressure and shipped and stored in liquid form. They are received at Steelton in tank cars and pumped into twelve horizontal tanks and one Hortonsphere having a combined capacity of 564,000 gallons. Storage pressures are 200 psi. for propane and 75 psi. for butane.

The amount of butane-air that can be added to the coke-oven gas is limited to about 15 percent of the final mixture because the specific gravity of the distributed gas must be kept within a certain range. Burners of consumers' appliances are adjusted for gas of around 0.52 maximum gravity (air equals 1). The gravity of the coke-oven gas varies from 0.38 to 0.43, whereas that of the butane-air mixture is above 1 (butane equals 2.01). If an excess of butane-air is added, appliance burners do not function properly.

Even before the liquid petroleum-air system was functioning in 1947, a survey of the potential sales for the winter of 1948-49 indicated that a supplemental source of gas would have to be provided before then and that more compressor capacity would be needed. Another Ingersoll-Rand gas-engine-driven unit was therefore purchased and went into service in 1948. Designated as the Type KVG, it is similar in design but larger than the two XVG machines that have been operating since 1943, being rated at 335,000 cubic feet per hour at 34 psi. discharge pressure.

With this addition, the Steelton plant can send out 1,070,000 cubic feet of gas per hour with all machines in use. Besides, the four steam-driven compressors at the Harrisburg plant can deliver 440,000 cubic feet per hour. It should be borne in mind in this connection that a gas company has to be prepared to meet the maximum demand that may be made on its facilities, even though that maximum is actually reached only once or twice a year. In Harrisburg, the daily send-out is about twice as great in winter as in summer. The average daily load in winter is between eight and nine million cubic feet, but a sudden cold snap may push it up temporarily to around thirteen million cubic feet.

The gas-distribution network consists of low-, intermediate-, and high-pressure systems. The low-pressure system is fed by the weight of the holders alone, and delivery is limited to a radius of about 5 miles. Most customers outside that range are supplied by high-pressure lines, which are fed by compressors at both the Steelton and Harrisburg plants. The pressure is normally 35 psi., but during peak loads it may reach a maximum of 50 psi. Where the high-pressure system feeds into low-pressure areas, the pressure is reduced by district governors. In areas of high-pressure distribution, individual house governors reduce the pressure to about 3 ounces to serve the gas-burning appliances. An intermediate-pressure system, that supplies one section in northern Harrisburg, operates at from 3 to 10 psi. Normally this pressure is obtained by bleeding gas from a high-pressure line. During peak periods, when high-pressure gas is not available for this purpose, an Ingersoll-Rand single-stage, turbine-driven turboblower in the Harrisburg station acts as a booster to increase the pressure of the gas coming from the holders there.

In 1947, after carefully considering the question of future gas supply, the company decided to avail itself of one of the latest developments in the technique of gas making. As a result, the most recent addition to the equipment at Steelton is a catalytic-cracking plant with an initial capacity of 5,000,000 cubic feet per day. Although the method has been employed since 1935 in industries where controlled atmospheres are required for heat-treating and kindred purposes, it is so new in the utility field that only four units have thus far been placed in service in the United States. In principle, its operation is similar to that of the "cat" crackers that were introduced in large numbers in petroleum refineries during World War II to make base stock for aviation-grade gasoline.

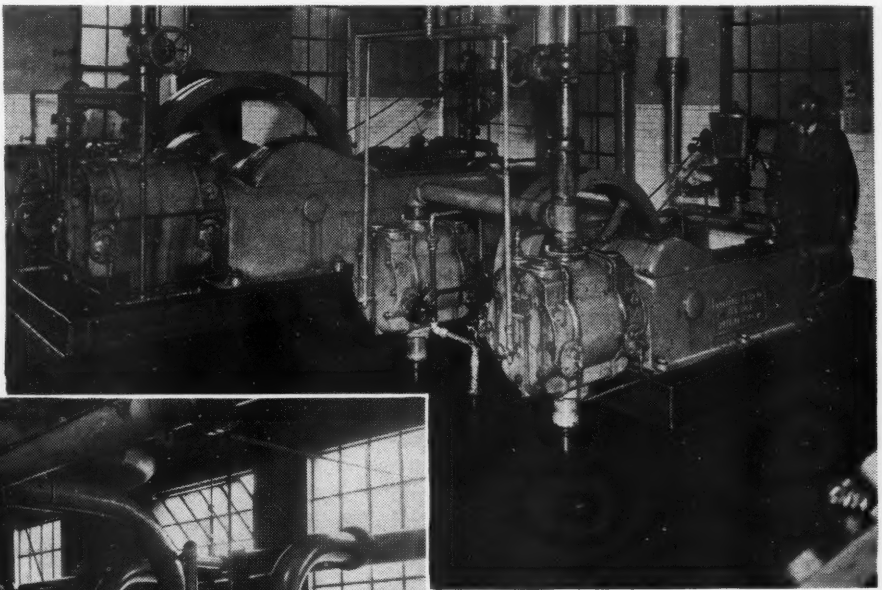
Essentially, hydrocarbon molecules are rent asunder by the action of heat and pressure in the presence of a catalyst and recombined under controlled conditions into gaseous compounds of desirable characteristics. A development of the Surface Combustion Corporation, of Toledo, Ohio, the gas-cracking plant can re-form any one of a number of hydrocarbon materials. Since it was put in service in 1948, the Steelton cracker has used only butane as feed stock, but initial equipment was provided to permit it to function with propane or gasoline as well. This includes a fractionating tower or still for separating gasoline into three components when and if it is desired to use it as a raw material. Distillation produces a light fraction that serves for enriching the final gas, an intermediate one for use as feed stock for the cracking furnace, and a heavy one that can be burned under the cracking furnace and boiler.

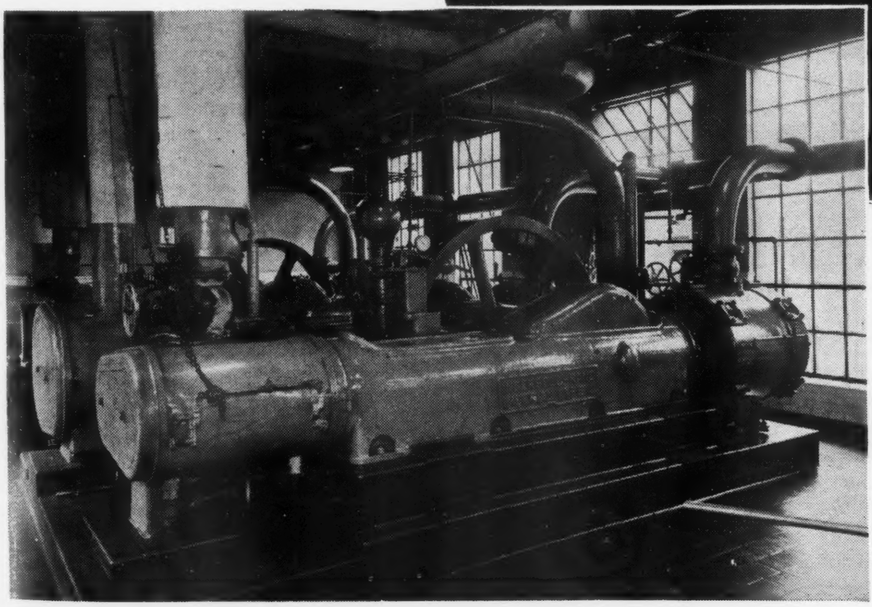
Cracking takes place in a bank of 32 vertical alloy-steel tubes, each 26 feet long and 8 inches in diameter. The lower 6 feet of the tubes contains carborundum, on top of which is 16 feet made up of pieces of firebrick impregnated with a nickel catalyst. Heat is applied to the tubes by oil burners, the operating temperature being around 1800°F. The gas-making process is as follows: Hydrocarbon vapor is mixed with a predetermined volume of air at 20 psi. pressure and the combination preheated to 340°F. Steam at 14 psi. and 240°F. is then added, and the final mixture enters the cracking tubes. There the hydrocarbon, steam, and air are dissociated and the resultant molecules are recombined to produce a gas consisting principally of carbon monoxide and hydrogen, together with small amounts of carbon dioxide, methane, and nitrogen. The methane is evidence of incomplete cracking, which can be remedied by increasing the heat applied to the tubes. The presence of carbon dioxide indicates an excess of steam input. The nitrogen is derived from the process air. The reformed gas is cooled in two stages to around 70°F.

A desirable feature of catalytic cracking is that, by adjusting the volumes of air and steam fed to the reaction tubes, the heating value of the re-formed gas may be varied from 180 to 380 Btu's and the specific gravity from 0.35 to 0.70. This makes it easy to turn out a product which, after enrichment, will closely correspond to gas being manufactured by other methods, thus eliminating troubles arising from mixing the two types. At Steelton, the cracker is operated to make a gas of around 315 Btu's and 0.40 specific gravity. When this is enriched to 520 Btu's by adding butane vapor, the specific gravity is increased at the same time to 0.52.

Other advantages of the process are: Operations are automatically controlled and only two men per shift are required to run the plant; the initial or capital cost is comparatively low; because gas is generated continuously and the output can readily be varied up to the maximum capacity, relief holders are not needed; if holders are used, the gas does not have to be pumped into them because the system can function against a discharge pressure up to 2 psi.; the re-formed gas contains no tar or other impurities and therefore does not require purification. Furthermore, no smoke or dust is produced.

The Steelton gas-cracking plant went into service on December 31, 1948, and was used during peak-load periods in the ensuing weeks to supplement the regular coke-oven gas supply. It actually functioned a total of 150¼ hours, during which time it produced at a rate averaging 168,240 cubic feet per hour, or a little more than 4,000,000 cubic feet per day. Because of the automatic controls, oper-





COMPRESSORS AT HARRISBURG

Four Ingersoll-Rand steam-driven compressors handle high-pressure distribution from the Harrisburg station, taking gas from holders. One of the units has been in service since 1914 and is shown above with M. J. Barry, plant foreman with 37 years of company service, standing at the throttle. The machine in the background was installed in 1920. Two more modern units are seen at the left.

SERVICE AND CONSTRUCTION EQUIPMENT

Almost 42 percent of the company's total capital investment is represented by underground mains and services. To maintain these facilities, extend them as required, and insure good service to customers, the company uses more than 60 trucks and other pieces of mobile equipment, as well as complementary hand- and power-operated tools. Among them are eight air compressors and a variety of air tools and appliances, including Jackhamers, paving breakers, and clay spades for making ground openings; tampers for compacting backfill; sump pumps for handling casual water; Multivane drills to facilitate making up pipe joints; and an Airlite safety lamp for illuminating gaseous underground spaces. The utility truck pictured at the upper-right carries virtually every tool normally needed in service work in compartments that are readily accessible by opening side covers. Inside is mounted an 85-cfm. air compressor. At the left is a close view of the compartment just back of the cab. At the top are reels of air hose and below them is an air receiver. The vertical tubes on the right wall are part of a filter system used in supplying fresh air to respirators worn by workers in confined gaseous areas such as manholes. In the separate space at the bottom is an Ingersoll-Rand PB-6 paving breaker with a supply of moil-point steels. In addition to the applications mentioned, compressed air serves to operate ejectors to induce a vacuum for clearing stoppages in services, to aerate gaseous soils with either air pressure or vacuum, to inflate or deflate large bags used in stopping flows of gas, and to drive pipe when renewing services or installing new ones. A trailer-mounted 60-cfm. portable compressor towed by a truck is show nat the lower-right. The service and construction department has approximately 180 employees.

ating the plant is extremely simple. To increase the output, it is necessary only to send more butane vapor to the cracker. Ratio controllers thereupon increase the flow of steam and compressed air to the point where the proportions are such as to provide a re-formed gas of the same composition as before.

Materials required per 1000 cubic feet of gas made during the operating period averaged: butane, 4.2 gallons; process steam, 22.8 pounds; process air, 64.1 cubic feet; oil for furnace heating, 1.4 gallons; oil for steam boiler, 0.48 gallon; cooling water, 350 gpm. Because the furnace has to be brought up to working temperature gradually, starting it from a cold condition takes about eighteen hours. So that it might be put more quickly into service, it was maintained in standby condition at a temperature of 1400°F. for a total of 1350 hours. In doing that, from 25 to 30 gallons of fuel oil per hour was consumed in the furnace and from 20 to 25 gallons under the steam boiler.

Looking still farther ahead, the company is planning to obtain natural gas to supplement its present supplies of gas and to stabilize the cost of production. Initially, it is planned to use about 2,500,000 cubic feet of natural gas per day. This will entail the construction of 18 miles of 8-inch steel pipe line from a point near Maytown, Pa., where it will connect with one of the transmission lines from the Southwest. When natural gas thus becomes available, probably early in 1950, it will supplement coke-oven gas as the base-load material. The natural gas will not be utilized in its existing form but will, instead, be re-formed—replacing butane (entirely or partially), as load requirements dictate. When using natural gas, the cracking plant can be made to produce daily around 9,000,000 cubic feet of 520-Btu. gas for distribution, compared with the rated capacity of 5,000,000 cubic feet when using butane.

During the mild-weather season of the year when the load on the system is light, there will be a surplus of natural gas that can be burned under the cracking furnace and steam boiler and used to operate the gas-engine-driven compressors. When the load increases in cold weather, oil can be utilized for heating purposes and butane in part for re-forming, thereby making it possible to produce large volumes of finished gas with the limited quantities of natural gas available.

Through these various developments, The Harrisburg Gas Company will enter upon its second century of service with highly efficient and flexible facilities that will meet all needs for some years to come and give its 46,000 customers surety that there will be no shortages or interruptions in the supply of the utility that has come to mean much to their comfort and well-being.

WEST PORTAL OF COMPLETED TUNNEL

The dual vehicular passageway, which forms the final connecting link in the Merritt and Wilbur Cross Parkway systems, was officially opened on November 1 by Gov. Chester Bowles of Connecticut. The twin 1200-foot bores cost $1,934,000.

West Rock Tunnel

First Vehicular Bore in Connecticut Pierces Basaltic Elevation

*Walter C. Maynard**

CONNECTICUT'S first highway tunnel passes through an elevation known as West Rock, located west of New Haven on the Wilbur Cross Parkway which, upon completion, will angle across the state and form a link in the through superhighway extending from New York City into northern New England. In the 1930's, engineers projecting the route for the parkway were faced with the problem of skirting New Haven as closely as possible and at the same time avoiding the numerous basaltic rock formations in the area. None of the several lines that were run looked well either on the ground or on paper. Finally, the best of the routes was projected on a map, and then a line was boldly drawn to straighten its most circuitous section. It passed right over the top of West Rock, an obstacle too stubborn to be hauled out of the way by bulldozers.

*Project Engineer, Connecticut State Highway Department.

When first proposed, the idea of tunneling through West Rock appeared preposterous because of the seemingly high expenditures involved. Later, however, investigation proved that the scheme was not so far-fetched as had been imagined. Cost estimates for the stretch incorporating the proposed tunnel were computed and found to compare favorably with those of alternate routes. To loop the parkway around the northern end of West Rock would have meant added distance, sharp curves, steep grades, and lengthy approaches leading into New Haven. A road south of the ridge would have necessitated cutting through thickly settled suburban areas. In the case of open-cut construction through West Rock, rock excavation would have reached tremendous proportions. When the cost of the right of way was included in the estimates, the tunnel proved to be the most reasonable proposition. In 1940 the opinion of the Connecticut State Highway engineers was substantiated by consulting engineers.

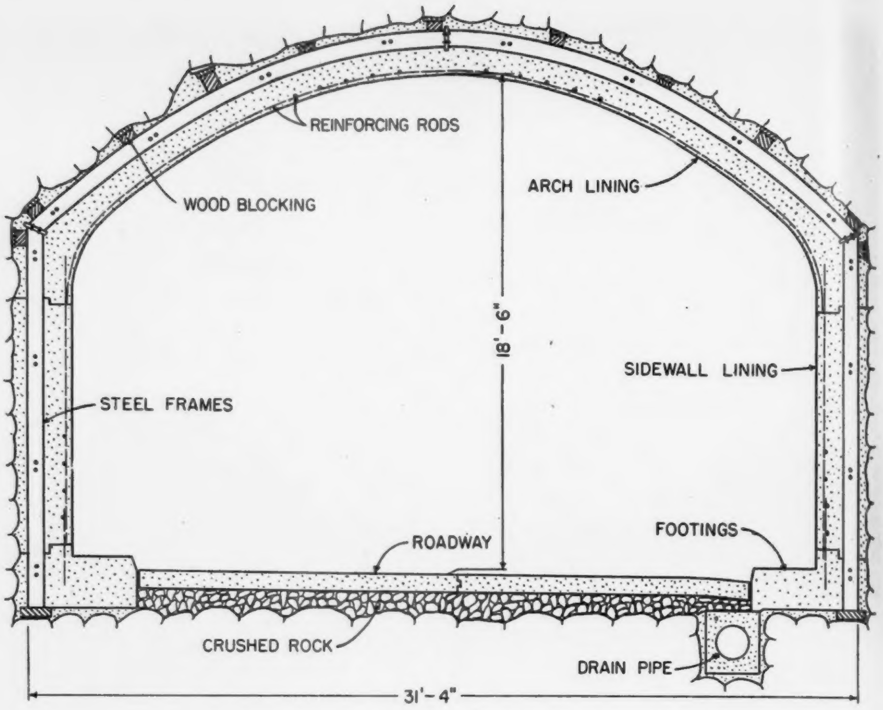
During the war years no work was done on the project. In 1945 the firm of Parsons, Brinckerhoff, Hogan & Mac Donald, consulting engineers of New York City, was commissioned to design the tunnel. Borings previously put down from the surface of West Rock and reaching below the proposed grade had disclosed hard trap rock from top to bottom throughout all but a short stretch near the west end where some 19 vertical feet of sandstone had been encountered.

The trap rock, geologically called diabase or dolorite, was a dark-green, fine-grained, homogeneous formation containing many small seams. Armed with that knowledge, the consultants drew up plans for two horseshoe-shaped tunnels 1200 feet long, 28 feet wide, and spaced 63 feet center to center. On January 8, 1948, a contract was let to L. G. Defelice & Son Company, Inc., and Gull

Contracting Company of North Haven, Conn., joint tenders of the low bid of $1,934,203.

Operations were started March 10, following the break-up of a severe winter. The first step was to clear a working place preparatory to opening up the portals and drilling, blasting, and mucking out the bores. Because the line was on an ascending 3-percent grade from west to east, tunneling was begun at the west portal to take advantage of natural drainage. Furthermore, about 85 percent of the material excavated was to be used as fill for the west approach.

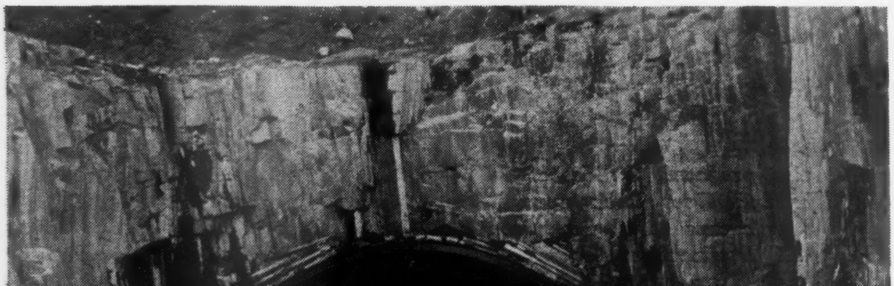
The contractors' plant was established at the west end and included blacksmith, carpenter, and general repair shops; a supply building for tools, spare parts, etc.; a battery of four 500-cfm. and four 315-cfm. portable compressors, all of Ingersoll-Rand make, and a 300-cubic-foot air receiver; pumps, fuel tanks, and other miscellaneous equipment. A change house and headquarters for the miners, complete with lockers and showers, also was erected. Temporary transformers were set up to supply 2300-volt current for construction purposes.



TYPICAL SECTION

Sketch shows dimensions and the construction method followed where steel supports were required.

Two drill carriages were built with bases consisting of Linn half-tracks and frames designed so that, when placed side by side, they dovetailed to form one jumbo. Two lines of vertical steel columns were set up longitudinally on each half-track and tied together with crossbeams, which supported three working decks. The lower and middle levels were provided with cantilever platforms on each side, while the upper deck, because of the tunnel contours, had sliding members that extended inside only. Each drill carriage was equipped with seven Ingersoll-Rand DA-35 power-feed drifters: two suspended below the bottom platform, two each on the first and second levels, and one on the top deck. The machines were mounted on swinging arms attached to columns so that any area of the working face could be drilled by one or more of them.

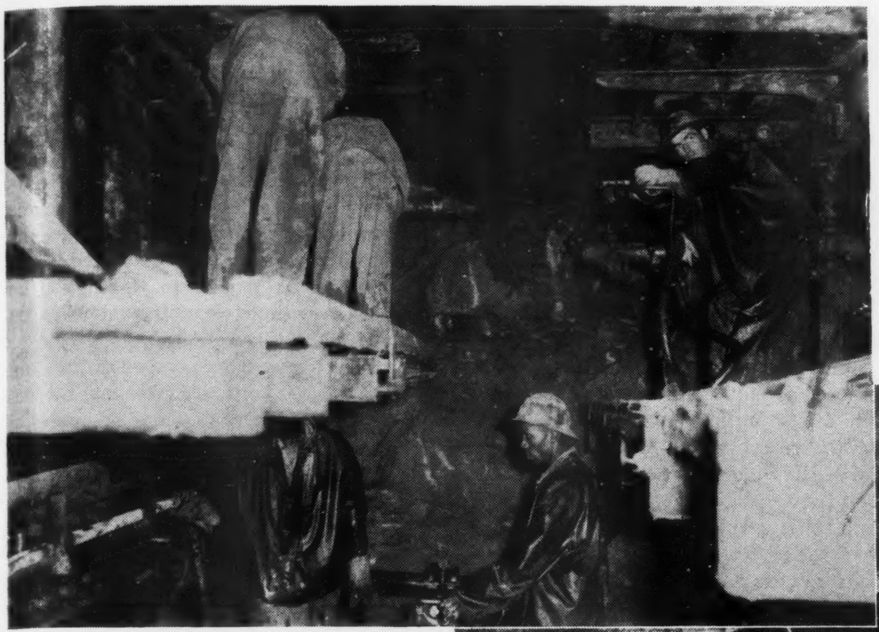


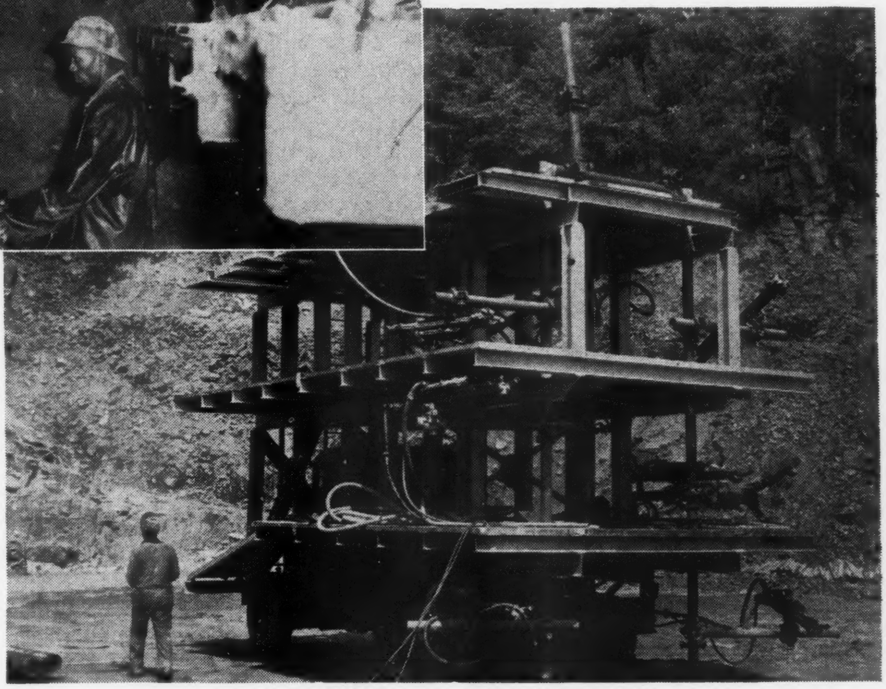
ONE OF TWIN BORES AFTER HOLING THROUGH

A view looking southward through the northbound traffic bore shortly after it was holed through and with steel sets in position preparatory to placing the concrete lining. This passageway will carry the stream of vehicular traffic that daily flows out of New York City toward Hartford, Conn., and points north. The columnar structure of the basaltic rock through which the tunnel was driven is clearly shown.

As the portal locations had been arbitrarily selected, it was recognized that the rock at those points might not extend to the elevations necessary to bridge the tunnel. The contractors were therefore advised to determine rock conditions for themselves, to establish the lines dividing open-cut and cut-and-cover work from actual tunneling. Pay lines for unclassified, portal, and tunnel excavation were fixed on the plans as vertical construction lines, but the contractors elected to excavate to a slope line which entailed the removal of an additional 27,000 cubic yards of earth and jingle stones at the west portal and some 14,000 cubic yards at the east portal, all of which had to be replaced at their expense before completion of the contract.

Work on the cut-and-cover and open-cut sections of both bores was started at the west portal in May. By the end of June they had been drilled, blasted, and mucked out. A 1½-cubic-yard Northwest shovel and four Mack trucks were used to move the material to the tunnel approach, where a Caterpillar D-8 bulldozer spread it in the fill area. When the contractors were ready to "turn under," the jumbos were moved up to the face of the north bore and the first round drilled —162 line holes 12 feet deep and 89 firing holes 4½ feet deep. The round was fired in three separate shots: the first, a wedge shot near the center of the heading; the second, the section of the tunnel remaining below the springing line of the arch; and the third, the arch itself. The pull obtained was 4 feet. A few days later the same procedure was followed in the south bore.





DRILL CARRIAGES

One of the two drill carriages built for the job is pictured below. This unit was only half of the complete assembly, for when a second duplicate machine was pulled alongside at the working face the two complemented each other and permitted drilling the entire blasting round without moving either one. The view at the left shows part of the two abutting units at the rock face with crews putting in a drill round.

Once started, work in both tunnels was carried on at about the same rate in two shifts of two crews each: one crew drilling, loading, and blasting a round in one bore while the other crew scaled, mucked out, and set steel frames in the other. The first shift was on from 6 a.m. until 2:30 p.m., the second shift from 2:30 until 11 p.m. This cycle of operations generally balanced in good style, although the second shift occasionally worked from one to three hours more in order to have a bore ready for the drillers on the morning shift. Mucking equipment was all diesel-powered, including a Model 78 Lorain 1½-cubic-yard shovel with a shortened boom and dipper stick to permit using it in the tunnel. Three Koehring 6-cubic-yard Dumptor trucks—carriers having a short wheel base and equal forward and reverse speeds—hauled out the excavated material.

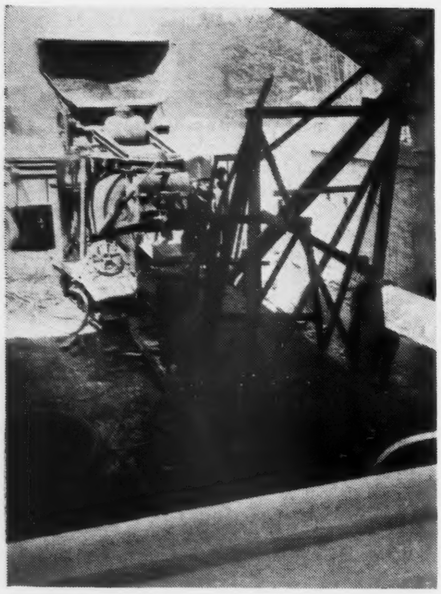
In the beginning, conventional detachable steel bits were utilized for drilling, but because they became dull after putting in 3 to 8 inches of hole in the tough trap rock a change was made to Ingersoll-Rand Carset (carboloy-insert) bits of 2-inch size. These proved to be good for an average of 300 feet of hole each. The 4-foot round used at the start was gradually increased to 8, then to 12, and finally to 13 feet. From 55 to 75 holes were drilled per round, with 4 to 6 forming a wedge-shaped cut at the center. The holes were loaded with Hercules Gelamite No. 2X dynamite and detonated with blasting caps in nine delays, the round pulling an average of 10-12 feet. Powder consumption in pounds per cubic yard of muck averaged 2.3 to 2.9, which was considerably lower than the contractors had estimated.

Tunnel walls and roof were braced by steel frames which will become an integral part of the concrete lining. They were fabricated by the Commercial Shearing & Stamping Company, and with few exceptions were set on 6-foot centers. The vertical members were placed by hand on footings of 4x10-inch timbers. The arch members were raised and bolted in position from the drill carriages, each of which was provided with an Ingersoll-Rand air-operated Tugger hoist to aid in this work. Any questionable rock areas remaining were blocked and shored with heavy timbers; and as a further protection for the crews, 3x10-inch temporary lagging was placed between the lower flanges of the arch section to guard against minor rock falls caused by vibration, air slack, etc. Large voids caused by overbreak from the tunnel walls during blasting were filled with grout by means of a pneumatic gun.

At a distance of 200-250 feet in from the portal both bores passed through several intrusions of igneous rock that was blocky, seamy, and considerably fractured, resulting in headings never entirely free of silt and mud seams. Farther along, the south bore penetrated a fault zone where the rock, though well compacted and cohesive, was almost completely crushed. Surface water draining into the tunnel along this zone caused much trouble. While excavating in this fault area at a point adjacent to the south tunnel and for the south-tunnel portal, ice was encountered as late as July and water proved a continual menace by undermining the steep slopes and causing landslides.

The bores were lighted at 20- to 30-foot intervals with 150- and 300-watt spotlights taking current from a 110-volt main line. At the working faces, reflectors attached to extension cords were used in the beginning but were so frequently "shot up" by blasting that they were replaced by cheap aluminum dishpans. Carrying two bulbs each, the pans cast plenty of light on the heading and stood up well under the barrages of flying rock.

Ventilation was effected by a 36-inch reversible fan that supplied 13,000 cfm. of air at 2 psi. pressure. Auxiliary reversible blowers on each side of the fan provided an additional 10,000 cfm. A metal pipe, 30 inches in diameter and suspended 7 feet above the floor, was run into each bore from the fan-and-blower installation to within a few feet of the face. This system speedily exhausted dust and fumes after each blast and maintained a satisfactory working at-



PNEUMATIC CONCRETE PLACER

The concrete lining was "shot" into the forms by a Press-Weld pneumatic gun using air at 80 psi. pressure to deliver the material from the mixer through a 6-inch metal pipe line.

mosphere at all times. The air was checked periodically to make sure that no unsafe concentrations of dust, carbon monoxide, or nitrous fumes were present.

While tunnel driving was progressing from the west portal, construction crews at the east portal were not idle. There, overburden was removed, cut-and-cover sections line-holed and blasted to predetermined tunnel-heading locations, and portal footings excavated. Four Ingersoll-Rand 315-cfm. portable compressors furnished air to operate four wagon drills used on the rock work. Muck was handled by a 1½-cubic-yard Northwest shovel, three 4-cubic-yard Mack trucks, and a Caterpillar D-8 bulldozer. It was stockpiled to be moved, later, through the tunnel and used in completing the west approach.

After holing through on November 8, 1948, drilling and blasting crews proceeded with the work of raising a vertical shaft at a point midway between the portals and the bores to provide the latter with permanent and continuous ventilation. First a 6-inch-diameter hole, 180 feet deep, was drilled to serve as a pilot bore. Cables were dropped down through this opening and attached to a platform upon which two men equipped with stopers were stationed. With this setup, an 8-foot-square shaft was drilled from the tunnel level to the surface. All stoping, loading, and blasting was done from the platform, which was raised by cables from a double-drum hoist after each round was taken out. The muck produced was allowed to drop to the bottom of the shaft, where it was shoveled up and hauled away.

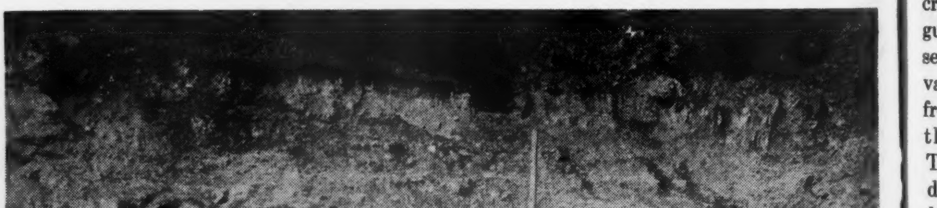
When within 20 feet of the surface, the crew encountered disintegrated stone which blocked the pilot hole, jamming the cables and preventing movement of the elevator platform. Failing in attempts to break the hold with dynamite, the contractors decided to remove the broken material from the surface by aid of a truck-mounted crane, which necessitated the construction of nearly half a mile of temporary road to get the heavy equipment up the mountainside to the head of the shaft. The latter was then enlarged to 16x16 feet by slashing—by firing charges placed in holes drilled parallel to the tunnel line. This work was started at the top and carried downward, the muck falling to the bottom. Owing to the columnar formation of the rock and the blocky, seamy ground encountered at various points, the walls had to be grouted as slashing proceeded. A total of 500 pounds of Sika also was required for the purpose of sealing water-bearing seams.

The shaft is lined with concrete throughout and is divided into four ducts made up of steel forms 6 feet in diameter and 8 feet long. Located at the bottom is the control room of the tunnel's ventilating system. Four 72-inch fans are installed there—two for each bore. These have a capacity of 82,500 cfm. each and exhaust air from the twin tunnel, forcing it up through the ducts. The reason for the four flues is to prevent air from one fan being "short-circuited" back into the tunnel by another fan. An octagonal-shaped house faced with random ashlar and provided with aluminum louvres has been built atop the shaft to serve as a weatherhood.

Concrete for lining the bores was prepared in a mixing plant erected near the west portal. Portland cement, transported by truck to the site from a railroad siding some 5 miles away, was dumped into a hopper and elevated to a storage bin with a capacity of 300 barrels. Coarse and fine aggregates were lifted from stockpiles to a 3-compartment bin by a 1½-cubic-yard crane. From storage, the materials flowed by gravity to scales where the correct amount of each for a 1-cubic-yard batch was weighed out and delivered by 3-compartment trucks to a single-drum mixer operating in the tunnel. The aggregate plant was housed to protect it from winter weather, and stockpiled aggregates were kept from freezing by fuel-oil fires in culverts made of open-end oil drums placed end to end under the piles.

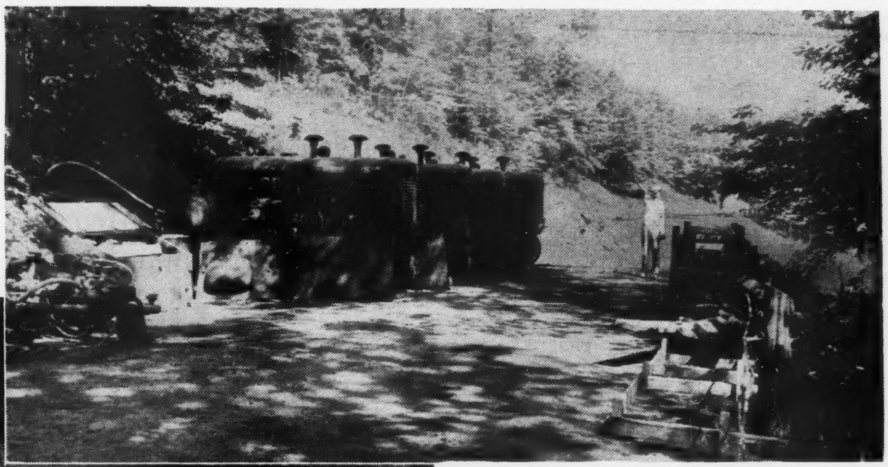
Whether inside or outside of the tunnel, concrete was placed in the forms at a temperature above 60°F. by the use of hot water supplied by a boiler and fed to each mixer through a 2-inch pipe covered with hay and sand. The safety curbs running along both sides of each bore were poured first by the aid of a chute extending from the mixer right into the forms. Power, lighting, telephone, traffic-control, and other lines are carried in fiber ducts embedded in the curbs, and beneath one of them in each bore is a concrete drainage pipe 15 inches in diameter.

The steel forms used in lining the side walls and arch were designed and manufactured by the Blaw-Knox Company. Made up of four separate 20-foot sections, each form was assembled on a frame riding on rails laid on the curbs. The sections of the wall or arch form, whichever was in demand, were hung free from this center frame and were moved into position by horizontal or vertical jacks, respectively. By means of these units, it was possible to pour 80



STARTING THE DOUBLE TUNNEL

This picture, taken on June 17, 1948, shows a power shovel (left) loading a truck with muck from the first round blasted in the northbound traffic bore. At the right, the two drill carriages are in position to put in the initial round in the second bore.



EXCAVATING AT EAST END

Four of the six Ingersoll-Rand wagon drills used for excavating rock in the open-cut sections of the east approach are shown in action at the left. They were supplied with air by the four Ingersoll-Rand 315-cfm. portable compressors pictured at the top.

feet of concrete wall on both sides of the tunnel at one time or 80 feet of arch, complete.

Concrete was placed by a 1-cubic-yard Press-Weld pneumatic gun mounted on a sled. A second sled carried an air receiver that was supplied by two 500-cfm. portable compressors stationed outside of the tunnel. Freshly mixed concrete was delivered from the mixer to the gun's discharge chamber, which was sealed by air-locked doors before the valve was opened to admit air at 80 psi. from the receiver to force the batch into the form through a 6-inch metal pipe. The gun is said to "shoot" concrete a distance of 800 feet in 35 seconds. A bulldozer was used to pull the frame and forms, as well as the sleds, ahead on the rails. The forms could be stripped from a finished section, moved forward, jacked into place, and bulkheaded ready to receive concrete in less than 3½ hours.

Another major advantage gained in placing concrete with the pneumatic gun was that of water control. By its use, excellent concrete with a slump averaging 2½ inches and less was delivered to the forms. It was determined beforehand that the side-wall and arch concrete should have a strength of 400 and 600 psi., respectively, before stripping the forms and moving them ahead. Six test cylinders were taken of each day's placement. When broken after a hardening period of 48 hours, the compressive strength was found to be as high as 1190 psi., and after 40 hours better than 550 psi., with an average around 880 psi. The actual setting time was therefore reduced to 40 hours, which enabled the contractors to pour three side-wall sections, or 240 feet per week.

The pavement laid throughout the tunnel and for 50 feet beyond each portal is of reinforced-concrete construction 8 inches deep. It rests on a base of crushed trap rock and is separated from each safety curb by a ¼-inch premolded expansion joint. Subdrainage is effected by intermittently placed 4-inch pipes connected to the main 15-inch drain pipe. Ramp drains running the full width of the pavement are located 25 feet in from the face of each portal. The tunnel walls are faced with glazed tile; and pink granite, quarried in Massachusetts and cut into dimension ring stones, quoins, shapes for turrets, etc., was used in building the portal walls, which are faced with random ashlar.

The ventilating system is regulated by carbon-monoxide detectors, two in each bore. In addition, there is a combination analyzer and recorder in the central control room that gives each tunnel three points of control, any one of which will start one of its fans whenever the carbon-monoxide content of the air approaches a dangerous concentration. If contamination continues and exceeds the point at which the control of the operating fan is set, the second one will begin to function. If there is a further increase, the traffic lights at the entrances will change from green to red and halt incoming vehicles until the fumes have been exhausted from that bore.

The lighting system is designed to meet both day and night conditions. General illumination is provided by 300-watt luminaires. These are spaced 30 feet apart, except within the first 100 feet at each end where they will be grouped more closely to take care of the transition from natural to artificial light. An electric-eye control system installed in each bore insures a minimum intensity of two foot-candles on the roadway at all times. For emergencies such as breakdowns of automobiles, etc., in the tunnel, caution and stop lights have been placed at regular intervals. Fire extinguishers are mounted in niches in the walls and wired so that removal of any one will automatically start a ventilating fan.

West Rock Tunnel, which is the final link in Wilbur Cross Parkway, was opened officially on November 1, 1949. An analysis made before work on the project was begun indicated that more than 13,000 cars a day will pass through the tunnel by 1950. Surveys conducted along the parkway since then have substantiated this figure. The connection is 0.7 mile shorter than the shortest of the alternate routes originally planned. Based on a conservative figure of four cents a mile, this should result in a saving to the motoring public of more than $130,000 a year in direct operating costs alone, to say nothing of the saving to the nation in gasoline, oil, rubber, and other vital materials. The judgment of those who chose to go through West Rock instead of around it has proved to be correct.

New Tacoma Narrows Bridge Rises

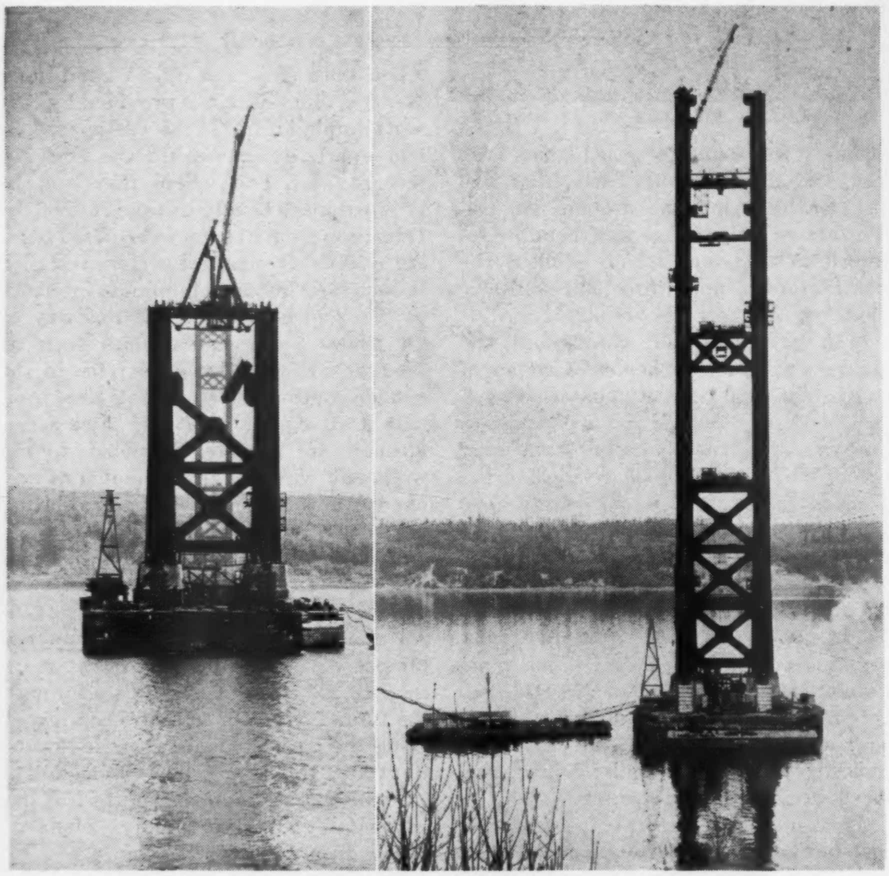
Stronger, Wider Structure Designed to Withstand Wind Pressure is Replacing One that Collapsed in 1940

A. R. MacPherson

THE essential part that compressed air plays in the building of bridges is well recognized by engineers the world over. Not so often realized, however, is the fact that compressed air, when delivered by the wild forces of nature, can wreck a great bridge.

The disastrous collapse of the ill-fated Tacoma (Washington State) Narrows Bridge during a storm on November 7, 1940, well demonstrates how the aerodynamic forces of nature in the form of compressed air or built-up wind resistance can destroy the mighty works of man. Engineers everywhere were shocked at the failure of the third longest suspension bridge in existence (7250 feet, including approaches) only four months after its completion.

After the span collapsed, engineers subjected some 30 different models of suspension bridges to wind velocities up to 100 miles per hour in a $100,000 wind tunnel at the University of Washington. There again compressed air, produced by great fans, played a vital role in revealing the reasons for the failure and in determining what changes and improvements should be incorporated in the new bridge to enable it to withstand the unusual wind conditions prevailing in the Narrows.



ERECTING CABLE TOWERS

The two river piers were found to be intact and sound and were incorporated in the new structure by building new and wider-spaced pedestals on them to support the legs of the broader, higher towers. Pictured at the left is the westward or No. 4 tower well started. Its companion, No. 5, is shown at the right, well along towards completion. On April 13, 1949, two days after this photograph was taken, an earthquake shook a 23-ton casting from the tower top. It crashed through the barge at the base, causing it to sink along with three air compressors and other machinery on board.

COLLAPSE OF FIRST BRIDGE

A section of the central-span roadway plunging into Puget Sound on November 7, 1940, after the structure had rolled and pitched in the wind. One automobile was on the bridge, but no one was hurt. A solid deck and stiffening girders, against which the high winds prevailing in the Narrows exerted an unbalancing force, were largely responsible for the failure of the mile-long crossing.

Through long research it was established that the original span collapsed because of its structural lightness and the effect of built-up wind pressure on wrongly designed closed sides and a solid roadway. In short, compressed air —wind pressure—started the long, slim span to bouncing up and down, ending

INTERNATIONAL NEWS PHOTO

in a corkscrew or twisting motion that tore it to pieces.

The bridge now rising at the same location will be a considerably larger and stronger structure. It will cost $11,200,000 and be financed by a $14,000,000 bond issue that will eventually be paid off by tolls. Charles E. Andrew, chief consulting engineer and builder of the span for the Washington State Toll Bridge Authority, is confident that it will stand for many years to come.

Misfortune has struck twice at the new construction: first in the form of a severe earthquake, and then, a few weeks later, a costly fire engulfed the main west tower. Losses through the destruction of tools, equipment, and the pier fender totaled $250,000, but fortunately neither of the two high steel towers was damaged. Despite these setbacks, the builders, Bethlehem Pacific Coast Steel Corporation and John A. Roebling's Sons Company of California, state that the bridge will be completed and ready for traffic as scheduled in July, 1950. Its purpose is to provide a short highway route between the Tacoma-Seattle area and Bremerton and the scenic hinterland of the Olympic Peninsula.

The two massive, $3,000,000 concrete water piers that supported the towers of the first structure are being incorporated in the new and wider one. They extend from the Narrows bottom to foundations at Elevation minus 225 and were originally made extra large because of the 15-foot maximum tides and 10-mile-an-hour tidal currents that surge against them. Inspection revealed that the piers were intact, as solid as when built, and fully capable of carrying the bigger span even though they had accumulated a healthy but harmless marine growth, estimated to weigh 580 tons, during the intervening years.

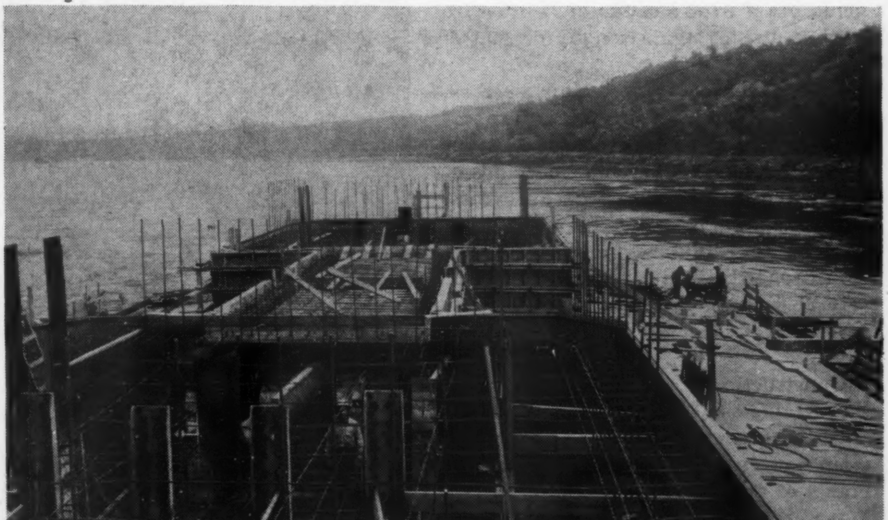
Construction of the new bridge called for the partial demolition of the original pedestals of the main piers and their rebuilding to a height of 24 feet above the old concrete. The two existing shore anchor blocks, six smaller piers, and four bents that supported viaduct approaches also were enlarged and reconstructed to accommodate the wider roadway and heavier cables. All concrete operations were carried out by Woodworth & Company, a Tacoma firm and subcontractors of Bethlehem Pacific Coast Steel Corporation, under the direction of Superintendent E. F. Starbard.

Rebuilding of the pedestals and the cable anchor blocks on both shores required exacting demolition work to prepare the old for the new concrete. After excavating around the blocks to their bases, blast holes were carefully drilled and loaded with dynamite to shoot 11 feet of concrete from each side. A total of 6000 cubic yards was thus removed. The blocks were then extended 8 feet laterally and 20 feet rearward with new concrete, which added 12,000 cubic yards to their bulk.

The cables supporting the deck structure will be attached to eyebolts embedded in the base blocks, each of which measures 110x90x50 feet, contains 26,000 cubic yards of concrete, and will withstand a pull of 18,000 tons. They were enlarged in order to accommodate the greater spread between cables—60 feet on the new as against 39 feet on the old span. During this phase of the work, compressed air was used to operate rock drills and four Ingersoll-Rand vibrators that compacted the concrete as it was poured. Two I-R portables furnished the air power.

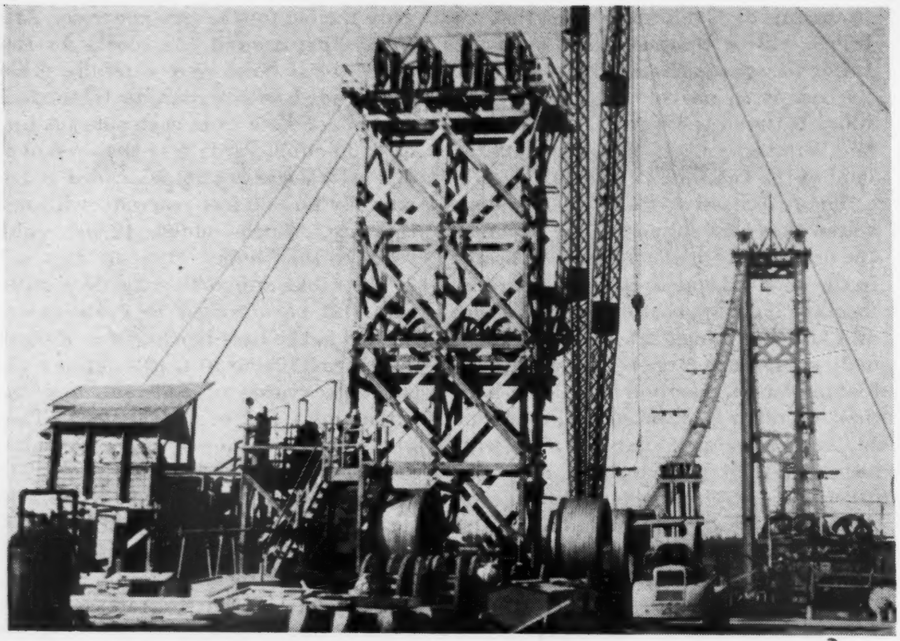
A comparison of the designs of the two bridges reveals how the engineers intend to overcome the previous defects. Instead of 8-foot solid stiffening girders, the present structure will have fabricated open trusswork 33 feet deep throughout its full mile length. Erection of the trusses, according to Mr. Andrew, will be the most difficult job on the entire project.

The roadway of the new span will have four lanes in place of two, and is to have five grilled slots, each 33¼ inches wide. These will allow wind pressures above and below the deck to equalize, which was impossible with the solid road



REBUILDING PIER PEDESTALS

Forms on one of the main piers ready to receive concrete for heightening the pedestals or supports of the two legs of the surmounting tower which will rise 502 feet above mean high water.



CABLE-SPINNING SETUP

Equipment of John A. Roebling Son's Company assembled on shore preparatory to spinning the 20⅛-inch cables from which the deck structure will be hung. At the bottom are reels of No. 6 wire, of which 20,000 miles will enter into the cables.

of the old bridge. The deck will be approximately 55 percent heavier and the trusses 58 times stiffer than the earlier ones. The weight of the structural steel for the entire span will total 15,500 tons, as against the previous 9200 tons.

The two main towers rise 502 feet above the water, as compared with 448 feet originally, and are 21 feet wider. The two cables will have a diameter of 20⅛ inches, as against 17 inches. They will weigh about 5300 tons and will be made up of 8702 strands of No. 6 wire having an aggregate length of 20,000 miles.

In addition to these design features, which are calculated to combat the aerodynamic forces that wrecked the first bridge, a novel damping mechanism, much like automobile shock absorbers, will be placed between the towers and the deck. Hydraulic cylinders will cause the latter to resist any tendency to roll, a fatal fault in the first structure that earned for it the ignoble title "Galloping Gertie."

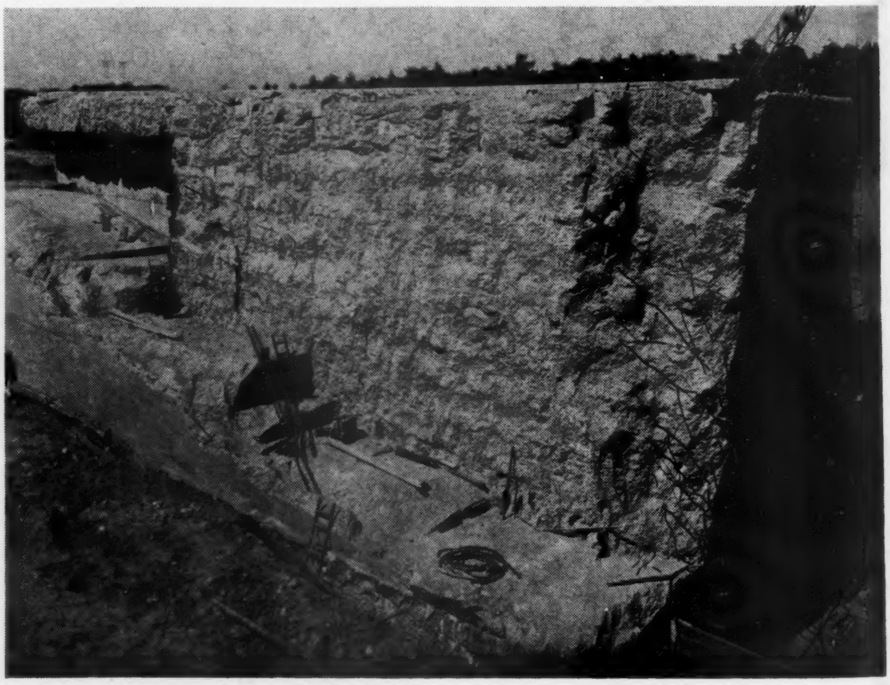
Construction of the bridge will entail the driving of 330,000 rivets with air-operated hammers. In erecting the two main towers, rivets were sent aloft to points of application by compressed air blown through flexible metallic tubes. The rivet heater only had to drop the bit of hot metal through a small trap door and press a button to put the pneumatic delivery system into use. Ten Ingersoll-Rand No. 534 impact wrenches speeded up the running of nuts in bolting and unbolting tower members during reconstruction, and compressed air also served to operate the boom of a traveling derrick that handled the steel for the towers. The derrick could be swung through an arc of 270° and, by means of blocks and cables, virtually lifted itself 70 feet at a time as the structures rose.

The main towers were completed in July, 1949, and turned over to the Roebling forces for cable spinning. Following the building of two 10-foot-wide catwalks, which extend from shore to shore over the tops of the towers, the cablemen began operations on October 17, putting in three shifts around the clock five days a week. They hope to finish their job in January, 1950, after which steelworkers and riveting crews will erect the trusses and the 756 ventilated roadway members that will make up the deck.

Because of the great distance from end to end of the working area, a modern radio-telephone intercommunication system was installed to connect various points with shore-based offices and the state highway department at the Capitol in Olympia. In addition, three walkie-talkies are used by the bridge surveyors to facilitate and expedite checking.

The three contracting firms and most of the engineers that built the original span are engaged on the present project. T. M. Martinsen is resident engineer for Bethlehem Pacific, and M. H. Fríncke is manager of erection. Robert J. Cole is erection manager for Roebling Son's Company.

In charge for the Washington State Toll Bridge Authority is Clarence B. Shain, director of highways and chief engineer. Under him is a board of consulting engineers headed by Mr. Andrew in direct charge of design and construction. Glenn B. Woodruff of San Francisco and John I. Parcel of St. Louis are board members, and Dr. Theo. von Karman is consulting aerodynamicist. Prof. F. B. Farquharson of the University of Washinton supervised the wind-tunnel research, and Kenneth B. Arkin was chief inspector for the state.



ENLARGING CABLE ANCHOR

Back face of the east anchorage after the earth had been removed from around it and a slab 11 feet thick had been blasted off the concrete mass. New concrete was then placed on the sides and rear to increase the bulk to 26,000 cubic yards. The bridge cables will be secured to eyebolts embedded in this anchor and the one on the opposite shore.

Pumping Mine Water with Jets

This Simple, Reliable, and Easily Handled Pumping Device Can Be Used for Many Purposes Underground

J. W. McConaghy

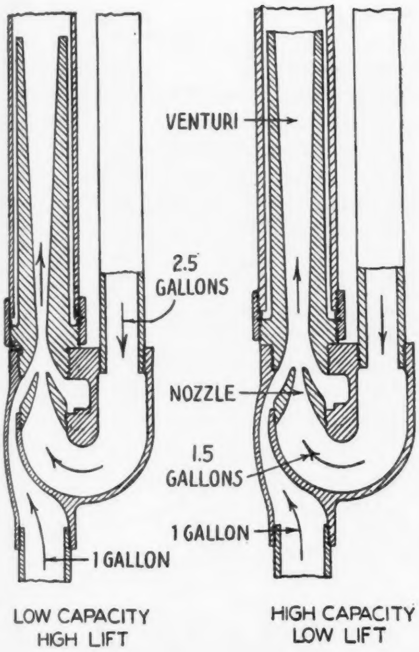


Fig. 1- JET CONSTRUCTION
Difference between two types is shown. In the case of either one, water forced down the passage at the right under pressure enters the throat of the venturi tube at high velocity and draws water in from below. The two streams merge in the gradually widening venturi and are sent upward into a discharge pipe. It is apparent that the jet, with no moving parts or complicating gear, is the simplest form of pump imaginable.

THE removal of water that collects in mines is a problem that has faced the industry since its early days. Great sums of money have been and are spent annually in pumping out rain water flowing in from the surface and seepage through porous formations from underground streams or reservoirs. Some districts are particularly wet. In the anthracite fields of Pennsylvania, for example, approximately 40 tons of water is removed for every ton of coal produced

Mine operators use a variety of pumping methods and equipment for drainage purposes. In sinking shafts and winzes through rock, where only a small amount of water is encountered, a bailing bucket, a reciprocating pump of the type known as a "sinker," or an air-driven sump pump may be adequate. Where larger quantities are involved, the sling yoke-mounted Motorpump has been found to be a compact and easily handled unit. Motorpumps and self-priming centrifugal pumps serve for draining low spots in drifts, crosscuts, and haulageways. At central underground stations, where water from various parts of the workings is allowed to accumulate and pumped to the surface, there are large multistage centrifugal units, or the work is done by means of deep-well turbine pumps installed through bore holes and driven from the surface.

The purpose of this article is to describe the jet method of pumping mine water and to point out some instances where it may be applied advantageously. The construction of a typical jet is shown in Figure 1. Water forced down the drive pipe under pressure emerges from the nozzle and enters the throat of the diffusor or venturi tube at high velocity, causing the pressure at that point to drop and water to be drawn into the jet, the two streams mixing in the diffusor. Because the latter widens gradually, the velocity then decreases and is converted into pressure, sending the water upward into the discharge pipe.

The jet is certainly the simplest type of pump imaginable, for there are no impellers, shafts, rods, valves, gears, or bearings one need be concerned about. Admittedly, its efficiency does not exceed 35 percent, but its inherently simple construction and resultant reliability frequently offset the power that is required to drive it.

The operating characteristics of the jet are similar to those of a centrifugal pump. They may be varied over a wide range by changing the proportions of the diffusor and the nozzle. Figure 2 shows the performance of a low-lift as compared with a high-lift jet, the curves being based on constant nozzle pressure. Working at a nozzle pressure of 300 feet and a discharge pressure of 145 feet, the high-lift jet needs 74.5 gpm. to pump 20 gpm. The low-lift jet, with the same nozzle pressure and a discharge pressure of 85 feet, requires only 131.8 gpm. to pump 100 gpm.

The small size of the jet pump and its lack of moving parts make it ideal for use in sinking operations. Two hoses are the only connections needed, no electric wires, air lines, etc., being necessary. It can be located so as to offer minimum

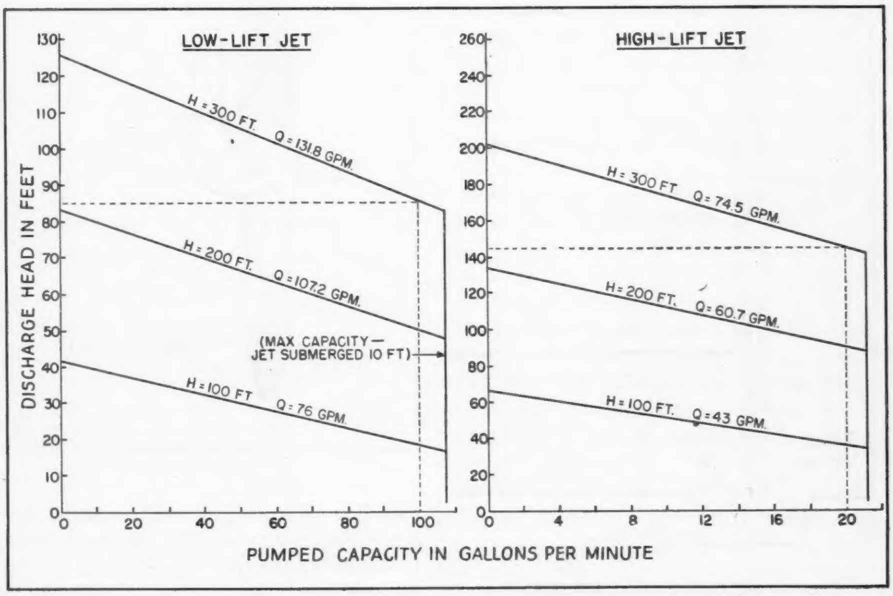


Fig. 2- OPERATING CHARACTERISTICS
Comparison of performances of 3x2½-inch low- and high-lift jets, with the nozzle pressures constant. H indicates the nozzle head or pressure in feet, and Q the nozzle quantity of water in gallons per minute.

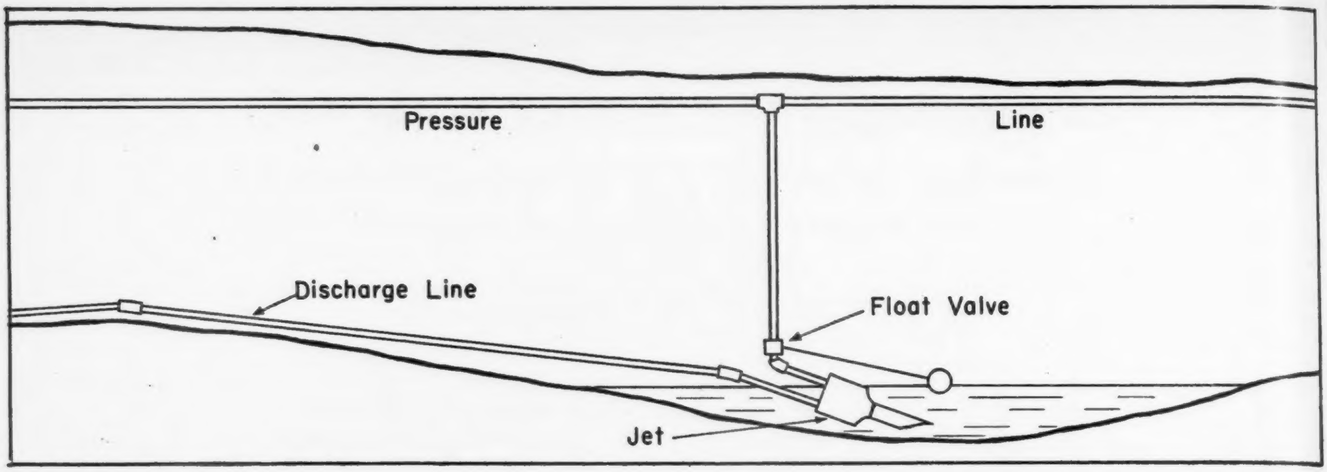


Fig. 3- SETUP FOR DRAINING MINE PASSAGEWAY

Here a jet is stationed in a low spot and equipped with a float-operated valve. Operating water is obtained from a pressure line or, if such a source is lacking, from a Motorpump.

interference with mucking and drilling and can be readily pulled up out of the way before blasting. It will handle a trickle of water or its maximum capacity with equal ease and without priming difficulties.

For automatically draining a low spot in a passageway, a jet with a float-operated valve can be installed in the pressure line. Figure 3 shows the setup for a system of this type. If a source of water pressure to operate the pump is not readily available, a Motorpump can be combined with it, an arrangement that permits diverting some of the latter's discharge water to the jet.

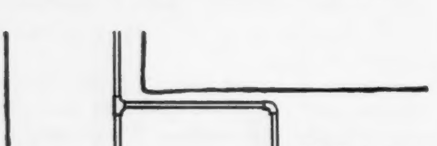
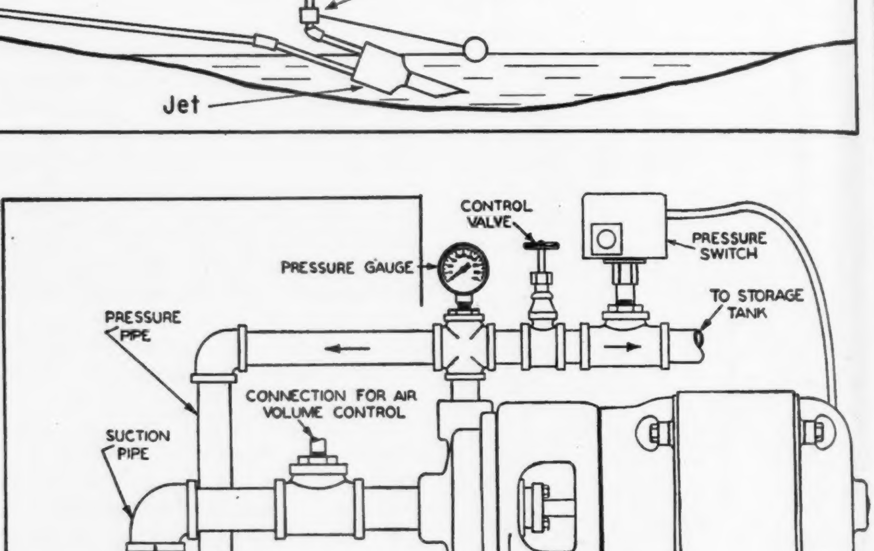


Fig. 4- SETUP FOR DRAINING A SUMP

Sketch shows how a Motorpump used for unwatering a sump may provide pressure for operating a jet pump at a lower level.



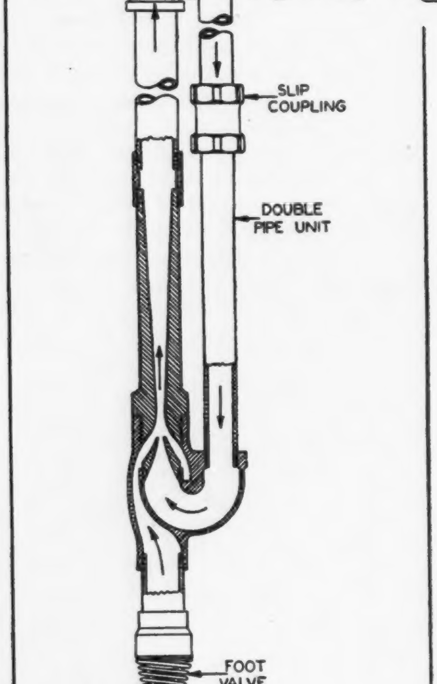


Fig. 5- A TWO-STAGE COMBINATION

With a jet serving as the first stage and a centrifugal as the second stage, some of the centrifugal's discharge furnishes operating water for the jet. This unit was designed for high-head pumping, and the distance between the jet and the Motorpump may vary greatly. With units designed for low-head pumping the jet is built as an integral part of the Motorpump casing.

A variation of this system is pictured in Figure 4. In this case a Motorpump is used for unwatering a sump and provides the pressure for a jet installed at a lower level. This setup presupposes that the centrifugal is in continuous operation or controlled by a float switch or other device in such a manner that the jet will never lack for water pressure. The sketch shows a float-controlled valve installed on the pressure line of the jet to throttle the flow out of the sump and make it equal to the inflow to the lower sump. The system will thus remain primed even should the suction of the jet be uncovered. To raise 15.3 gpm. a distance of 100 feet by the high-lift jet referred to in Figure 2, it would be necessary to select a Motorpump for a 60.7-gpm. discharge and a 200-foot head.

Other jet- and centrifugal-pump combinations may be made for specific purposes. The installation in Figure 5 pictures a jet mounted below a centrifugal to form a 2-stage pump with the jet act-

ing as the first stage and some of the centrifugal's output driving the jet. This arrangement has several advantages. Primarily, it permits a centrifugal pump to lift water from a level that is well below the usual 20-foot suction limit; in fact, the lift may be several hundred feet if necessary. Secondly, because the liquid thus pumped flows through the centrifugal, its pressure is increased and it may, consequently, be delivered to the surface or to a higher level.

The operating characteristics of the system just described are shown in Figure 6. By adjustment of the jet proportions, the combined curve can be varied over a wide range. Note, however, that sufficient nozzle pressure must be maintained to keep the installation working—to get the liquid up to the suction of the centrifugal. It is therefore necessary to have a control valve on the centrifugal discharge so as to throttle it if the back pressure is not high enough to operate the jet.

Because a jet system must always be full of water in order to be ready for service, the setup should be equipped to take care of all possible contingencies. For instance, a stone may become lodged under the poppet of the foot valve, causing it to leak and all the water to drain out. To cope with such a situation, the volume of the discharge piping should exceed that of the sump from which the jet is pumping. Then, if what has been described should take place, the float switch would start up the unit because of the rise in the sump's water level, thus washing the obstruction from the seat. But if it did not do so, the jet would simply be running unnecessarily and continue to function until shut down for valve repair or replacement.

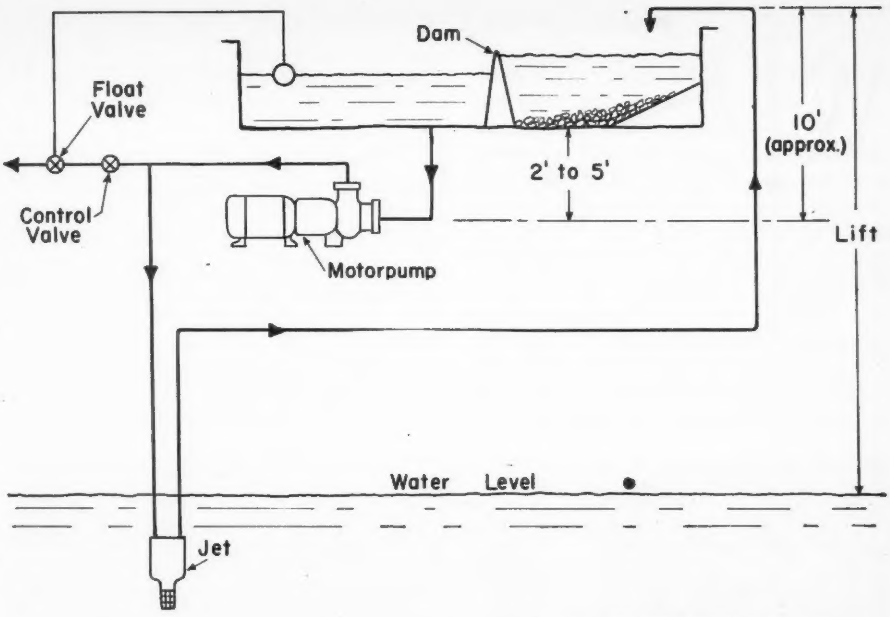


Fig. 7- MAINTENANCE OF PRIME ON JET

The diagram shows a divisional dam in the open tank at the top to prevent sand and other material sent up by the jet from getting into the centrifugal pump.

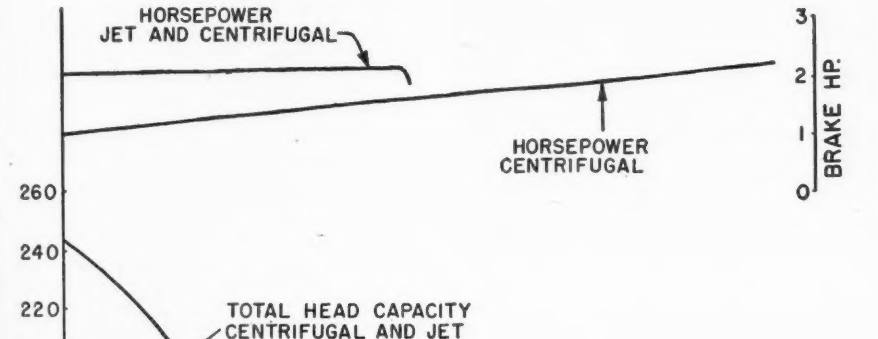


Fig. 6- OPERATING CHARACTERISTICS OF FIGURE-5 SETUP

The performance curve of the combination unit can be varied over a wide range by adjusting the jet proportions.

Another way of nullifying the danger of uncovering the jet is shown in Figure 7. In this case it discharges into an open tank with a pipe connection to the suction of the centrifugal and with a float that operates a valve on the discharge of the centrifugal pump. If the jet should for some reason be exposed, then no water other than that operating the jet goes up the pipe to the tank. The water level in the latter falls, causing the float valve to throttle the discharge and thus maintain the system's prime. In the event sand is brought up by the jet it can readily be kept separate by putting a dam in the tank. That would lessen wear on the impellers of the centrifugal. While a centrifugal pump is shown in the sketch, a rotary or reciprocating type could be used. The system would then take on the characteristics of a rotary or reciprocator; that is, maintain constant capacity at variable pressure.

In calculating the performance of jet systems, allowance should be made for the piping between the jet and the centrifugal pump. For information along this line the reader is referred to *Centrifugal and Axial Flow Pumps*, by Dr. A. J. Stepanoff, which contains a discussion on the calculation of the combined characteristics of such systems.

Emergency Cutoff for Natural-Gas Pipe Lines

WITH an incoming or suction-side pressure in the neighborhood of 400 psi. and a minimum discharge pressure of 750 psi., a tremendous volume of high-pressure gas moves through intermediate compressor stations on a long trunk line. This gas, should a line break or fire occur in one of the stations, represents a hazard that may destroy the structure and all its equipment. To prevent possible disaster, the gas must be cut off not only from the suction or downstream side but also from the line ahead because the high pressure gas there will expand and reverse its flow in case the compressors are shut down.

To insure proper and immediate closing of the control valves in its compressor stations, one transmission company, which maintains two parallel lines each 20 inches or more in diameter, has installed an automatic system of closure and venting that requires no manual "wheeling" of gates by the personnel and that is actuated from a point near the station-operator's house. That point is a good 200 yards from the station and is readily accessible to any man off duty or may be reached by one on watch as he takes himself from the danger zone.

Each valve, with the exception of the one controlling the suction, is equipped with an air motor. This unit may be powered either by air from engine-starting tanks, where compressors are driven by internal-combustion engines, or by gas taken out of the main and stored under the desired pressure in a tank of ample capacity to insure all valve motors full operating cycles.

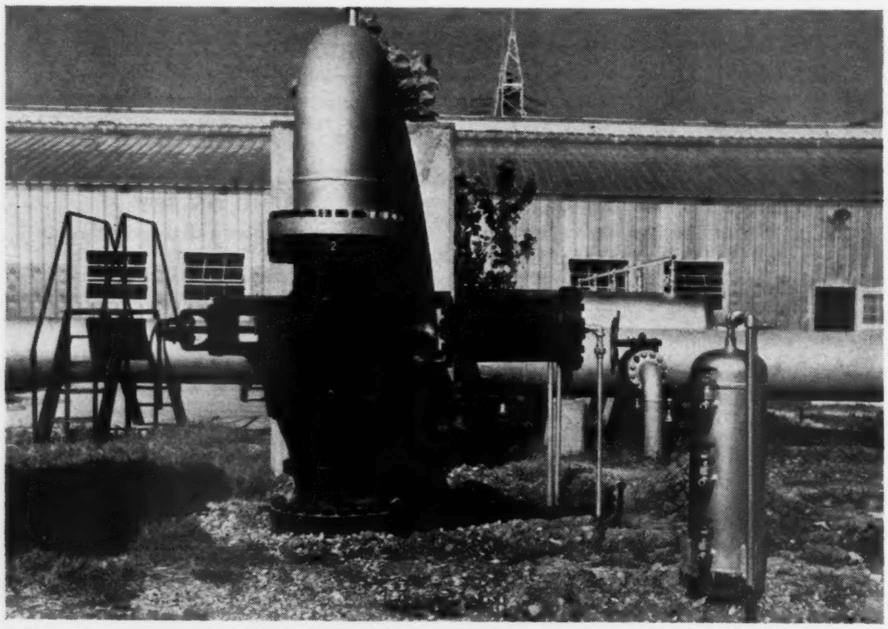
Because it is necessary that the incoming gas be cut off first, the suction line is controlled with a quarter-turn plug valve the stem of which is fitted with a gear into which meshes a toothed rack. The latter is powered by a hydraulic cylinder with a stroke of sufficient length to assure complete and quick valve closure. Oil under pressure is fed to the cylinder from a storage tank mounted adjacent to it; and gas or compressed air, admitted at the top by the operation of an emergency stop control, forces the oil down into a storage tank, out through a pipe at the bottom, and behind the cylinder piston, thus actuating the plug. To reopen the valve the oil is displaced, returned to the tank ready for the next cycle. Test cocks in the side of the tank make it possible to check the oil level.

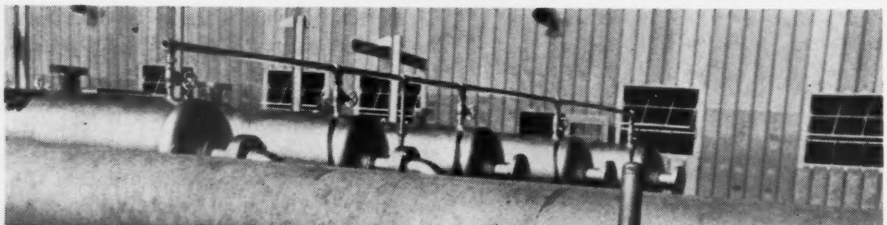
The valve that controls the discharge from the compressors into the line leading to the next station in the transmission system is closed by an air motor which begins to function when the plug-type suction valve is being closed but which, owing to a threaded screw on the valve stem, does not seat until after suction has been cut off. At the same time—while the main discharge valve is being "wheeled" by compressed air or gas—a second valve is similarly closed in the line tying together the two parallel lines so as to equalize throughput pressures.

After the motors and cylinder have cut off the flow into and out of the compressors in the station, another motor valve opens in a sequence operation to vent the station piping to atmosphere so as to prevent pressure build-up in the gas trapped between the closed suction and discharge gates and any possibility of explosion from that source. This vent is located far enough from the station so that any exhausted gas cannot become fuel in case of fire or endanger equipment and personnel.

A pressure of 275 pounds is maintained in the storage tank, and 1-inch steel lines carry the high-pressure gas or air from the master control valve to the motors on the three gates to be "wheeled" and to the inlet at the top of the tank which delivers oil to the hydraulic cylinder on the suction line.

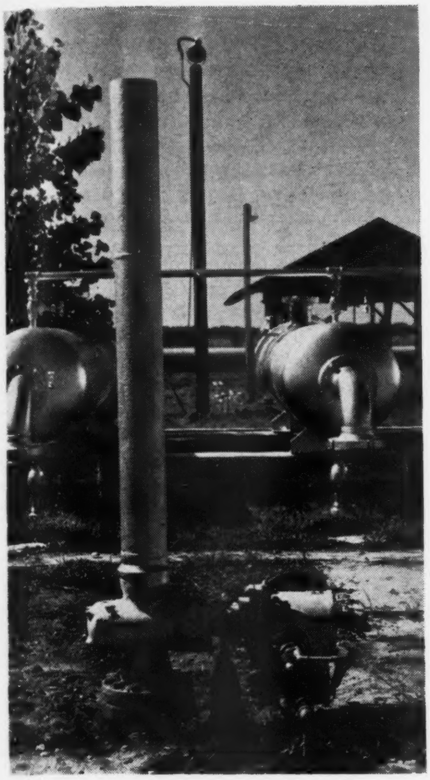
The system is not subject to possible





APPARATUS FOR STOPPING FLOW THROUGH STATION

Top picture- The valve on the incoming line to the compressor station is controlled by a rack and pinion actuated by the horizontal cylinder projecting at the right. When oil in the vertical tank in the right foreground is displaced by compressed air or gas entering through the line at the top, it is forced into the cylinder and operates the piston. To reopen the valve, pressure is admitted ahead of the piston, forcing the oil back into storage in the tank when a vent valve is opened. Bottom picture- The valve on the right closes the discharge to outgoing lines, thereby preventing the pressurized gas in them from blowing back into the station. The valve on the left closes the by-pass line that ties the two trunk lines together for pressure equalization.



EQUIPMENT FOR VENTING STATION PIPING

After the flow of incoming and outgoing gas has been stopped, the valve shown here vents the gas in the station piping to atmosphere at a safe distance from the station buildings. This is done so as to prevent pressure build-up in the gas trapped between the closed suction and discharge gates, thus eliminating the possibility of fire or explosion from that source.

interruption from outside causes, as might be the case were closures effected electrically. The operating tank, once charged, requires no attention except periodic checking for pressure, and the master valve is so simple that any member of the crew can put it to use without danger of error.

Frequent tests are made of the cutoff so as to be sure that it will be in condition to take over in an emergency; and with only short sections of the lines exposed, weather has little effect on the system. In addition, limiting devices prevent the torque developed by the air motors from reaching a value that will overload the latter or cause the gates to jam.

Where compressed air is taken from the station's engine-starting system, a separate tank is provided, the same as with gas drawn from the main line. This makes the valve-closure system independent of all other equipment at the time it is supposed to function. The control valves in each station are also fitted with hand wheels, permitting them to be operated either manually or by means of the air-operated facilities when normal conditions prevail and no emergency exists.

Construction Magazine Compiles Almanac of Industry

INCLUDED in a recent special seventy-fifth anniversary issue of *Engineering News-Record* is "An Almanac of Significant Events in Building a Greater America." Representing the result of extensive and careful research, it records, in concise form, the dates and events since 1874 that marked the "ever-steady, and at times spectacular, progress of this sprawling, complex, dynamic colossus we call 'engineering construction.'" The information is segregated under headings covering the principal fields of construction. From it, we have culled the following items that pertain to the application of compressed-air and vacuum equipment.

Foundations

1874. First large and deep pneumatic caissons completed for Eads Bridge, St. Louis, Mo., and begun on Brooklyn Bridge, New York City. With later perfection of process by Geo. S. Morison on his several Missouri and Mississippi River bridges, precedent was set from which only changes in detail have occurred in 75 years.

1893. Introduction of pneumatic caissons, equipped with new Moran air lock, to building foundations occurred on Manhattan Life Building in lower New York. Not until 1927 was any other method used for skyscrapers in areas where rock was overlaid by water-bearing material.

1900. Walls formed by a series of pneumatic caissons sunk around Mutual Life Building in New York by Alfred Noble and T. Kennard Thomson. Joined by Daniel Moran's concrete-filled pneumatic joint, these caissons excluded water, thus making large, deep basements possible.

1913. Freezing process used on department-store foundation in Berlin, Germany, to permit excavation through water-bearing sand.

1930. Sand islands built up at pier locations for Southern Pacific's Suisun Bay Bridge in California permitted caissons to be sunk as on land.

1936. New type open caisson, a 92x197-foot box designed by Moran & Proctor in which dome coverings over dredging wells permitted the use of compressed air to control flotation, was sunk to a record depth of 224 feet for great central anchorage of San Francisco Bay Bridge. Method permits almost unlimited caisson flotation depths.

Buildings

1935. Hayden Planetarium (80-foot span) in New York City introduced thin-shell dome roof construction in the United States. First of this type was the planetarium at Jena, Germany, constructed in 1924. Since then, thin-shell roofs as arches have been developed much further, with a record-breaking span of 340 feet being used for hangars at Rapid City, S. C., and Limestone, Me., in 1949.

Concrete Dams

1900. Grouting of foundation for Tallahassee Dam in Florida. This practice, improved on later jobs, made it possible to build dams on fissured foundations. Pioneer work in grouting was done on Holter Dam (Montana, 1910) and Bow River Dam (Canada, 1910). Stage grouting, developed much later, was applied extensively at Hoover Dam in 1933.

1928. Pipes put in Owyhee Dam for grouting concrete joints were used to make experiments in circulating cooling water. Results encouraged full-scale pipe cooling at Hoover Dam.

1933. Concrete placed with aid of vibrators (both internal and platform type) on Pine Canyon (Morris) Dam for Pasadena water supply. Permitted use of drier concrete, saving in cement, and better placement of concrete in difficult spots.

1934. Drilling large cores (36-inch diameter) at TVA's Norris Dam made it possible for engineers and geologists to be lowered into the core-drill holes to examine and photograph undisturbed formations.

1943. Dense surface imparted to spillway of Shasta Dam by vacuum mats which, through atmospheric pressure and suction, removed excess water from the concrete. Such use of vacuum mats was extensive by 1949.

Highways

1887. Numerous local organizations of wheelmen consolidated into the League of American Wheelmen. It started the first good-roads movement.

Construction Machinery

1884. Automatic steel-rotation incorporated in the old cam-and-piston rock drill.

1896. Hammer-type rock drill invented. Lighter than previous drills, this tool gained quick acceptance.

1897. Pneumatic riveting hammer helped in the demand for quicker steel-erection methods.

1899. Portable air compressor widened the versatility of compressed-air power.

1909. Compressed-air machine for "slugging" concrete through pipes against gravity was the first concrete pump.

1912. Jackhamer, a one-man rock drill, developed.

1931. Detachable drill bit eliminated transporting long steel for resharpening.

1934. Off-the-highway dump trucks and wagons first built. Their big rubber tires enabled them to operate in soft ground that would bog conventional units.

Tunnels

1874. Hoosac tunnel, in western Massachusetts, completed. Power drills and dynamite were adopted for the first time on this 4¾-mile rail-tunnel job.

1879. Hudson and Manhattan tunnel work begun at Hoboken, N. J. Light iron liner plates used. On this, the first compressed-air job in the world, the builders tried to drive without a shield, but experienced a blow-out that cost twenty lives. Work resumed with a pilot bore, but stopped again in 1882 after a progress of 1600 feet.

1885. Second Croton Aqueduct to New York begun. With its 40 shafts and 80 headings it was a useful drilling school.

1888. Shield and cast-iron liner plates

first used on a compressed-air job in America—on the 21-foot-diameter international railroad tunnel under St. Clair River at Sarnia, Ont., Canada.

1908. New York Subway tunnel put into service between the Battery and Brooklyn. This was the first tunnel built in the East River's difficult mixed ground (rock, sand, clay).

1909. Gunnison Tunnel, Colorado, holed through. This 6-mile bore was a pioneer U. S. Reclamation Service tunnel for carrying irrigation water.

1932. Boulder Dam diversion tunnels, 56 feet in diameter, completed well ahead of schedule with aid of truck jumbos that worked 75 percent of the face area. (Total length 3 miles.)

1936. Yerba Buena Tunnel, part of San Francisco Bay Bridge, became world's largest tunnel: Inside width, 65½ feet; height, 48¼ feet; length, 540 feet.

1941. Carlton Tunnel completed. This 6-mile hole drains deep mine workings in Colorado's Cripple Creek district. Single-heading record, 1,879 feet in a month, was made here.

1944. Delaware Aqueduct, an unprecedented 85-mile rock tunnel, placed in service to bring water to New York. Work had been conducted from 31 shafts under 12 contracts.

1947. First irrigation water passed through 13.1-mile Alva B. Adams Tunnel under Continental Divide in Colorado. Longest bore ever driven from only two headings.

Sewage Disposal

1916. First activated sludge plant put into operation at San Marcos, Tex., following process development by E. Bartow, F. W. Mohlman, and T. C. Hatton.

1923. Vacuum filtration of activated sludge successful on an experimental scale at Milwaukee, Wis.

Water Supply

1883. Croton Aqueduct Commission organized. This predecessor of the New York City Board of Water Supply had, by 1890, completed the project which set a precedent for the long aqueducts of later years.

1913. Los Angeles Aqueduct completed to convey water from Owens River, 233 miles away.

1908. The great works of the Catskill water-supply system for New York City completed.

1934. Water from the Hetch Hetchy Reservoir flows through a 155-mile aqueduct and arrives on San Francisco peninsula—33 years after the first appropriations were made.

1936. Development of a Delaware River supply for New York City starts with construction of the 85-mile aqueduct.

1937. First water drawn from the west slope of the Rocky Mountains through the Moffat Tunnel initiates a large-scale, long-range supplemental program for Denver, Colo.

1941. The great 1600-second-foot, 400-mile Colorado River Aqueduct completed by the Metropolitan Water District of Southern California.

Water Purification

1910. First ozonation plant for water disinfection on the American Continent put into service at Lindsay, Ont., Canada.

This and That

Closer Timed Blasts

The recent development of SP (short-period) delay detonators makes it possible to fire a series of blasts in much more rapid sequence than before. Closer timing is of importance in several lines of work. In mining and tunneling operations, it results in greater fragmentation of the rock, thereby decreasing loading costs. It also leaves a cleaner, less shattered face that facilitates drilling the next round. In quarrying, the need of secondary firing is reduced; and in blasting of all sorts, ground vibration and air concussion are lowered. Safety in mining and tunneling operations is consequently increased, and in excavation work it is permissible to blast closer to structures than before and not endanger them. Ordinary electric delay detonators provide an interval of a second or two between shots, whereas the SP type cuts it to as little as one twenty-five thousandth of a second.

Explosives engineers in Canada, England, and the United States independently began efforts to reach the same objective about four years ago. The first SP caps were marketed in this country, with the Canadian product appearing soon afterward. The new delays contain a rapid-burning powder that generates heat without forming gas, which would build up pressure and perhaps upset the timing. Essential constituents are oxygen and a fuel that reacts with the oxygen. Because the heat would ignite the explosive charge, the crux of the problem was to develop mixtures that would burn at almost infinitesimally varying rates so as to insure the split-second timing intervals between blasts. One of the researchers' difficulties was to find a means of timing the rapidly occurring explosions. This was solved by the use of an electric clock, or counter chronograph, developed during the war.

"Who's the boss around here?"

★ ★ ★

Padded Cell for Engines

Noises of internal-combustion engines are measured and recorded at the Illinois Institute of Technology in a rubber-mounted, double-walled, insulated room that is claimed to be the only one of its kind. Engines ranging from a 1-hp. lawn-mower unit to a 1000-ton, 2000-hp. diesel have been tested there by Prof. Wilson P. Green of the mechanical engineering department and their noises reduced by as much as one-half. The engines are stationed outside the room, and the noises from various component parts are piped into it, one by one. The loudest, usually the exhaust, is measured first, and then each gear, piston, and other moving part is checked. With the measurement made, the part is studied with a view to finding ways of reducing its noise.

★ ★ ★

Reinforced Concrete 100 Years Old

The centenary of the invention of reinforced concrete was observed in Paris last month under the sponsorship of the cement-manufacturing industry. The process of making cement for construc-

"I've an idea he had outside help."

tion purposes was originated by Vicat in 1820, but concrete placed in forms was first used by Francois Coignet in 1847 in putting up a building. In the next year Lambot constructed a boat of reinforced concrete. In 1849 Monier built flower boxes and Coignet the first floor of reinforced concrete. Following these beginnings, French engineers used the material for some years, and then the practice gradually became world-wide.

★ ★ ★

Metallurgists Best Paid of All Engineers

A recent survey by the American Society for Metals of half the metallurgists in its membership indicates that these technicists average higher salaries than any other group in the engineering professions in the United States. Those who reported have an average annual income of $6567, as compared with $4668 for all fields of engineering as recorded by the U.S. Bureau of Labor Statistics. Lawyers average $5719, chemical engineers $4320, all college graduates $4689, and all workers $4840. The typical metallurgist receives $3700 in his second year out of college, $5500 after five years, $6500 after ten years, and $8100 after twenty. His income reaches $9000 in 30 years and then gradually decreases. The survey shows the influence on income of additional college degrees: metallurgists with bachelors' degrees average $6601; masters', $6877; and doctors', $9122.

★ ★ ★

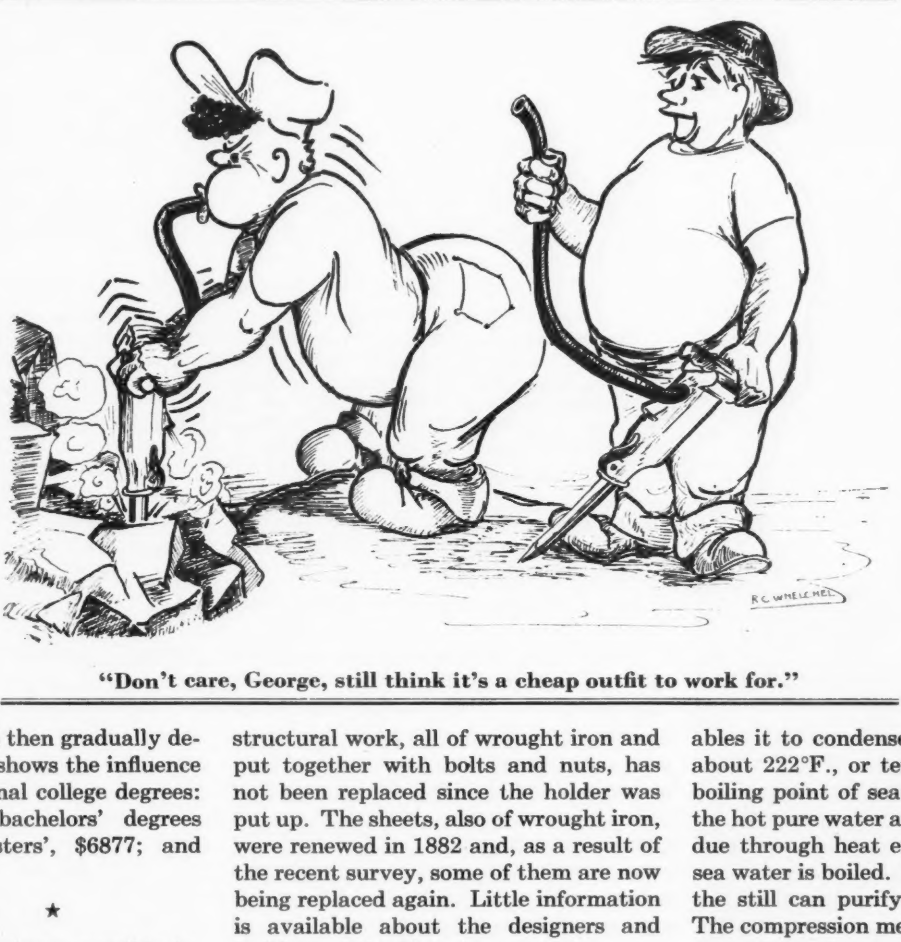
Gold Hoard Nets Mine Nice Profit

Foreseeing a possible increase in the price of gold, one of Canada's leading producers—McIntyre Porcupine Mines Limited—withheld from the market about two years ago metal then worth $6,436,-042 and representing substantially one year's output. The recent 10-percent devaluation of the Canadian dollar automatically raised the price in the Dominion $3.50 an ounce. The McIntyre hoard is, consequently, now worth $7,079,646, representing a gain of $643,604. At last reports the mine was still holding the gold. McIntyre made a larger profit by a similar maneuver prior to the 1933 increase in the world price of gold from $20.67 to $35 an ounce.

★ ★ ★

Gas Holder in Service 120 Years

At a recent inspection of facilities at the Fulham, England, gas works attention was called to the fact that one of the gasholders there has been in continuous service since 1829. It is 100 feet in diameter, 29½ feet high, and has a capacity of 226,000 cubic feet. Records indicate that it was considered a giant when built, for of the holders in service at that time the biggest was only half as large in diameter and it had approximately one-sixth the capacity. The structural work, all of wrought iron and put together with bolts and nuts, has not been replaced since the holder was put up. The sheets, also of wrought iron, were renewed in 1882 and, as a result of the recent survey, some of them are now being replaced again. Little information is available about the designers and builders of the historic receptacle.



"Don't care, George, still think it's a cheap outfit to work for."

★ ★ ★

New Cast Iron Can Be Bent

Ordinary cast iron is brittle because most of its carbon content is in the form of flakes that slide over one another under stress with poor resistance to breakage. Metallurgists of the International Nickel Company have found that it is possible to obtain a spheroidal graphite structure by adding a small amount of magnesium to the molten metal and thus produce a ductile cast iron. Although U. S. patents on the process were granted only a few weeks ago, more than 40 companies are already using it under licenses and making up to 700,000 pounds daily. Parts of the new metal are entering into machinery serving many industries.

★ ★ ★

Compression Distillation of Water

Pure water produced in compression stills, a fairly recent development, is being used in numerous industrial plants and on many ships. The process is licensed by Arthur D. Little, Inc., which originated it prior to World War II at the instance of the U. S. Navy Department to solve the problem of fresh water on submarines. By the time Pearl Harbor was attacked, apparatus was in production and was subsequently utilized with telling advantage by our landing parties on Pacific Ocean islands. When hostilities ended, our forces had enough equipment to supply the daily water needs of more than one million men. Details concerning its operation and military significance were given in our May, 1946, issue.

Briefly, sea water, for instance, is boiled and the steam put under about 3 psi. pressure, which enables it to condense into pure water at about 222°F., or ten degrees above the boiling point of sea water. By running the hot pure water and the hot brine residue through heat exchangers, incoming sea water is boiled. In a similar manner, the still can purify any impure water. The compression method is the lowest in cost of any known distillation process.

Compression stills are being used to provide potable water for pipe-line builders in Arabia and other isolated areas. At home, they are serving pharmaceutical and chemical plants, breweries, and other establishments which need pure process or boiler-feed water. Although their chief purpose is to supply uncontaminated water, they sometimes function in reverse where a concentration of "impurities" in the residue is desired. Examples are the recovery of penicillin beer, lignin waste, etc., from industrial solutions.

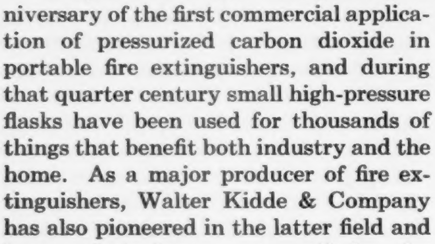
High Pressure in Small Cylinders

A LIFEBOAT IN THIRTY SECONDS

A pull on the rip cord seen in the top picture releases carbon dioxide from a cylinder and inflates the upper tube of this rubber "abandon-ship" boat made by B. F. Goodrich Company. As pressure builds up, gas is automatically admitted to the lower tube. The craft thus formed is 14 feet long, 6 feet wide, and holds twelve persons. Thirteen others can keep afloat by grasping the rope handrails along the sides. Four wooden paddles, a flashlight, signal kit, fishing outfit, and seine are included in the equipment.

THE pressure of modern living usually denotes a condition that makes life hectic and difficult, but the kind of pressure we're talking about comes in small, lightweight cylinders and makes life easier and safer in some respects than it would otherwise be.

This year marks the twenty-fifth anniversary of the first commercial application of pressurized carbon dioxide in portable fire extinguishers, and during that quarter century small high-pressure flasks have been used for thousands of things that benefit both industry and the home. As a major producer of fire extinguishers, Walter Kidde & Company has also pioneered in the latter field and is manufacturing pressure cylinders for rechargeable soda siphons, cream-whipping devices, medical gas dispensers, paint and insecticide sprayers, carbonated soft-drink vending machines, automobile-tire inflators, chemical-gas vessels, and for a multiplicity of other purposes.



INSTANT WHIPPED CREAM

Cream is whipped in this Kidde-made container by turning the knob to puncture a small cartridge containing harmless nitrous oxide. Half a pint of cream is fluffed into 1½ pints and then discharged by turning the knob in reverse. Unused contents can be stored in a refrigerator.

Thousands of lives were saved during World War II by projectile-proof steel flasks that made it possible quickly to inflate life rafts; that provided emergency power to operate aircraft landing gear, wing flaps, and bomb-bay doors; and that functioned as oxygen breathing apparatus. Pressurized containers of carbon dioxide likewise served to clear and charge jammed machine guns, to expel guided missiles and rocket fuels, and as flares and other signal devices.

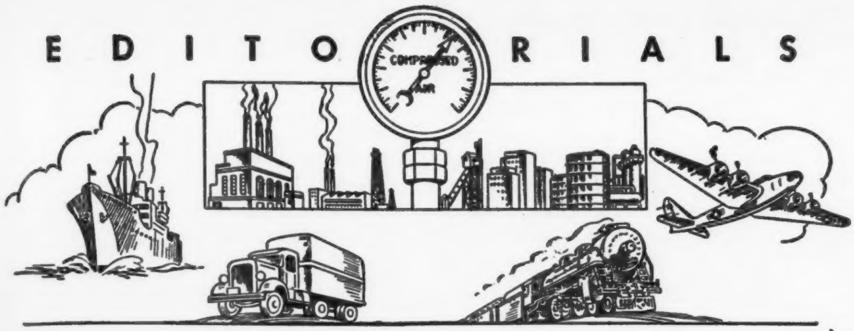
Every tank built during the war was equipped with a fire-extinguishing system including one or more small high-pressure cylinders containing the fire-smothering carbon dioxide. Gunfire-resistant flasks of the same type, containing compressed extinguishing agents, were and are widely used on military and commercial aircraft to protect their engines, fuel spaces, and cargo compartments against fire in the air.

Through modern manufacturing and valve-sealing techniques it is feasible to make extremely lightweight, thin-walled units to hold without leakage such gases as carbon dioxide, nitrogen, oxygen, helium, argon, ethylene, and methane. They are cold-drawn from special chrome-molybdenum alloy steel on huge hydraulic presses and operate at service pressures of 500 psi. and more.

The gases with which they are charged possess a tremendous amount of stored energy. Three pounds of liquid carbon dioxide, for example, will produce 100 hp. during a one-second release. Yet the safety record of these cylinders is phenomenal—for not one accident or casualty has been attributed to the improvements that have permitted reductions in weight or wall thickness.

Applications of small, high-pressure flasks are practically unlimited, says Daniel B. Mapes, vice-president of Walter Kidde & Company. In the field of specialized compressed gases, it is probable that cylindrical containers will eventually be replaced by spheres because the latter will allow an even greater weight saving for a given volume. And metallurgists may some day overcome the brittleness of aluminum or magnesium alloys so that these superlight metals can be used to make pressure cylinders.

EDITORIALS



FUTURE METAL SUPPLY

WHERE will the world turn for its supply of base and noble metals a hundred or five hundred years from now? Probably to the earth's crust, as it does today. For, despite the increasing rate at which known ore bodies are being depleted, mining men are confident that there will be new discoveries in sufficient numbers to meet the demand. Where do they think these finds will be made? For the most part, they favor the areas contiguous to existing deposits, and this for the logical reason that structural and other geologic conditions in those places have already been proved favorable to the accumulation of commercially valuable ores.

As is the case with petroleum, there is much conjecture about the future national supply of metallic minerals. No one disputes the cry that we are extracting ores at an alarming rate, and there are many who deplore the fact that world wars serve to dissipate vast quantities of metals in foreign lands where there is little chance of our retrieving them. Nevertheless, leaders of the mining industry are inclined to agree that we have so far located only a small percentage of the payable concentrations of ores that exist in the outer crust of the earth.

Take, for example, Canada, which is already recognized as one of the great storehouses of mineral wealth. Vast expanses of that country's rock surface are hidden by a mantle of soil and muskeg. Most of the deposits that are now being worked came to the surface and could be found without too much difficulty. For every one of these exposed showings, it is contended, there are a dozen or more concentrations that do not come to the surface. Locating them will not be easy, but new geophysical methods will help simplify the task. Already they have reduced the element of chance in finding oil fields, and it is reasonable to assume that they will render mineral prospecting a similar service when they are applied on a comparable scale.

This does not mean that the old-time prospector will no longer be useful. On the contrary, mining geologists consider that there will always be a place for him. For one thing, great areas in isolated regions still have not been examined closely. They may harbor exposed showings of ore that await only the glimpse of practiced eyes. A case in point is the recent discovery of enormous iron-ore deposits in Labrador. Many of these come to the surface, and any experienced prospector would have recognized them. Trappers passed over them for years, giving them no heed because they knew nothing about rocks and were interested only in furs.

The painstaking, unhurried prospector of the old school is likewise deemed likely to be the most efficient person for seeking additional deposits in districts where there are already operating mines. This is true, according to Dr. Christopher Riley, chief geologist for Pioneer Gold Mines of British Columbia, because "the secret of prospecting is continuous hard work and dogged persistence. The drive for this is the well known optimistic outlook of the prospector."

Prospectors are more intelligent than their predecessors were and they do a better job. Where overburden exists, they probe for bedrock with a slender, pointed rod, and some can identify the type of rock by the sound. Another effective method is to work upstream, panning the moss that adheres to rocks and catches particles of gold. Where the gold showings stop, the search for a lode begins. Employing this technique, the late Malcolm McKay, one of Canada's leading ore detectors, discovered a promising new gold deposit in British Columbia.

Some significant facts support the theory that the best place to look for ore is an area that is already producing it. Approximately 40 districts in the United States have furnished around 80 percent of all our metals to date. During the period of intensified output for war purposes from 1940 to 1946, thirty-six districts supplied 97.6 percent of our copper, 93.3 percent of our zinc, and 92.8 percent of our lead. All these areas, except the lead-zinc fields of Oklahoma-Kansas-Missouri, are said to have been found by prospectors. In substantially all of them, energetic field work has repeatedly extended the limits of productivity. Actually, no new producing district of any importance has been discovered in the United States during the past 42 years.

Advances in metallurgical practices also can be counted upon to increase supplies of commercially minable ores. Millions of tons of material too low in value to pay treatment charges at the time it was mined has meanwhile been recovered from dumps and processed profitably. Additional vast quantities of low-grade ore were left in place by early miners for the same reason. Mass mining methods and milling efficiency have already reclassified some of them—put them into a paying category—and still others will reach that status as extraction and treatment methods continue to be improved.

WHITE HOUSE REPAIRS

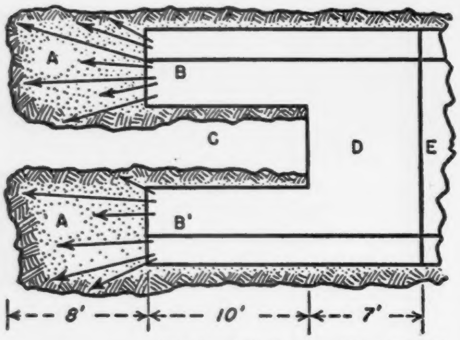
INVESTIGATIONS attending the remodeling of the White House in Washington, D. C., have brought to light that the weaknesses of the historic structure can be ascribed to the fact that, like Topsy, it "just growed." Built in 1790 by James Hoban, winner of a design competition, it was rebuilt in 1814 after a fire set by the British had practically gutted it. Since then it has undergone two major renovations and numerous alterations to modernize or increase its facilities. These latter piecemeal jobs are primarily responsible for the impairment. Numerous places have been detected where walls and joists were overloaded. According to W. E. Reynolds, commissioner of public buildings, it is a wonder that a major catastrophe did not occur.

One conclusion of those who explored the structure to determine its true condition is that good timber can take a lot of punishment. One place was discovered where joists with a normal depth of 11 inches had been cut to a depth of only 2 inches to install pipes for modern plumbing. In another, the ends of 18-inch joists had been notched to a depth of 13 inches to permit setting new steel beams. As a result, they had split for a distance of 4 feet from their points of support. Concerning them, Mr. Reynolds said: "How any timber could stand up for 45 years under such treatment is hard to imagine—force of habit, perhaps."

One of the interior brick walls supported a truss that had been loaded far beyond the limits recommended as safe by the National Bureau of Standards and had consequently cracked from the third to the first floor. Apparently, our chief executives for some years past have been in danger of having their domicile fall in on them like a house of cards. It will take a year to complete adequate corrective measures. The restored residence will, however, retain its traditional lines and appearance, even to the white-paint exterior that gave it its name. The identifying color, incidentally, was originally applied to cover up scars left by the fire of 1814. Prior to that time, the building was called the "President's House."

Loose Sand Made Stable by Chemical Impregnation

IN DRIVING a 2700-foot storm-water tunnel in San Francisco, Calif., the ground penetrated changed within such short intervals that test borings were not always an indication of what lay immediately ahead. Hardpan, gravel, clay, as well as firm and free-flowing sand were encountered in advancing the tunnel, which is of 10-foot section and horseshoe-shaped. It was driven in two drifts by the heading-and-bench method and progressed satisfactorily until dry sand



Courtesy, Engineering News-Record

PLAN VIEW

Sketch shows heading-and-bench method by which tunnel was driven through hardpan, gravel, clay, and sand. A, stabilized areas, with arrows indicating where and to what depth injection needle was inserted; B and B[1], drifts; C, core; D, bench; and E, tunnel floor.

was struck. To hold it in check, the contractor tried covering the headings with breastboards, but this procedure was inadequate because the material still flowed in even through small cracks between lagging and timbers. It was then decided to solidify the sand by injecting a chemical solution by means of a 10-foot, ½-inch pipe or needle and a reciprocating piston pump powered by air at 100 psi.

A mixture of sodium silicate and sodium bicarbonate, the latter a reacting agent, was used and could be varied to give the sand a consistency ranging from soft to the hardness of rock. The chemicals were supplied by the Philadelphia Quartz Company of California, which worked out the proportions so that setting would not take place for from 40 to 80 minutes after admixture and application in order to prevent damage to the pump and injection lines.

The work, after operating difficulties had been ironed out, was conducted as follows: The chemicals were delivered in 55-gallon drums and stored in surface tanks connected by pipes with two mixing drums that were set up as close to the drift faces as practicable. Each had a capacity of 55 gallons, and when one was in use the other was being filled. One man was in charge of the pump and measured and mixed the chemical ingredients; another injected the solution, regulating its flow by means of a plug valve between the pipe and hose connection.

The quantity required for stabilization ranged from 30 to 45 gallons for each cubic yard of sand, depending upon its moisture content and loss through voids in the formation. With a pressure of 200 psi. at the discharge pipe and an injection period of one minute it was possible to solidify an area within a radius of one foot from the tip of the needle, both pressure and time interval varying with the ground.

In free-flowing sand, the entire face of each drift was stabilized by repeated insertions of the needle and usually for a distance limited only by its reach. The core and bench, which were well protected by timbering, rarely required treatment; but where the supports were subjected to a heavy load both vertically and laterally, the arch and sides were impregnated to relieve the strain on the timbers and thus prevent bending or fracturing.

Tooling Stored in Shrouds

FOLLOWING in the footsteps of the Navy, which has put many of its fighting craft in moth balls (COMPRESSED AIR MAGAZINE, June, 1947), the Douglas Aircraft Company is doing the same thing with airframe jigs, fixtures, and patterns so that they will be ready for use when needed. Tooling of this type is large in size and fabricated from iron pipe, steel, and plaster. To prevent it from deteriorating in storage, sometimes for a period of years, was a difficult problem until the company adopted the methods by which the Navy protects its inactive ships, together with their ordnance, machinery, and other vital equipment, from the harmful effects of moisture.

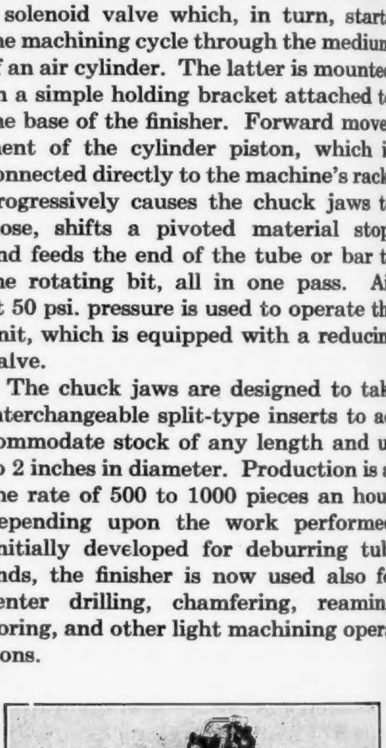
Now, iron and steel jigs and fixtures to be held in reserve are covered with an easily strippable plastic by spraying them with a standard fast-drying enamel after all machine surfaces have been well greased; by applying ¾-inch masking tape to form 6-inch squares; by filling in the spaces between the bands with a webbing agent—a spiderweb-like plastic—by means of a spray gun; and finally by applying first a light-weight plastic coating to prevent breaking the thin film and then a heavier one until the layers have a combined thickness of approximately 1/16 inch. Before the second coat is sprayed on, all sharp corners and crevices are sealed with Pliofilm tape. If complete dehydration of the air within the package is desired, this may be accomplished by placing bags of silica gel or other moisture-adsorbent material, together with a humidity indicator, behind a Pliofilm window in the envelope.

In the case of plaster patterns, taping and webbing are unnecessary, but the surfaces must be covered with a thin film of lard oil to prevent the plastic from sticking and pulling away bits of plaster during the stripping operation. When so protected, patterns of this kind can be stored in the open indefinitely without damage from the weather and without the breakage to which they are normally subjected when stored in racks.

Tube and Rod End Finisher

TO MEET the demand for a fully automatic machine, Pines Engineering Company, Inc., is now offering two tube-rod end finishers that are essentially alike except that the original model is operated by a hand lever and the new one is pneumatically controlled by a foot switch. Pressure on the latter actuates a solenoid valve which, in turn, starts the machining cycle through the medium of an air cylinder. The latter is mounted on a simple holding bracket attached to the base of the finisher. Forward movement of the cylinder piston, which is connected directly to the machine's rack, progressively causes the chuck jaws to close, shifts a pivoted material stop, and feeds the end of the tube or bar to the rotating bit, all in one pass. Air at 50 psi. pressure is used to operate the unit, which is equipped with a reducing valve.

The chuck jaws are designed to take interchangeable split-type inserts to accommodate stock of any length and up to 2 inches in diameter. Production is at the rate of 500 to 1000 pieces an hour, depending upon the work performed. Initially developed for deburring tube ends, the finisher is now used also for center drilling, chamfering, reaming, boring, and other light machining operations.

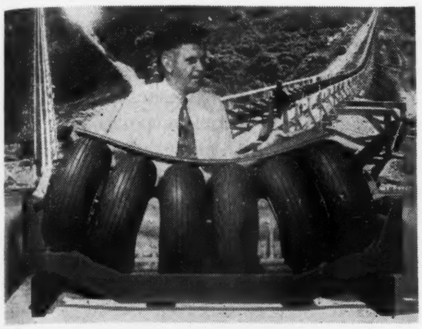


AIR-OPERATED MACHINE

This unit is mounted in a vertical plane to facilitate the unloading of short pieces. At the top is a foot-controlled Bellows air cylinder through which the threefold job of chucking, shifting the stock stop, and feeding the work to the tool bit is performed in one pass.

Industrial Notes

Some years ago, belting engineers of the Goodyear Tire & Rubber Company introduced a pneumatic cushioning idler for installation at transfer points in belt conveyor systems. Recently they re-

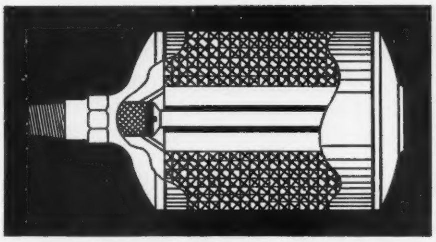


designed it, using airplane tires that have much greater shock-absorbing power than the narrower, harder industrial tires used previously. It also offers greater latitude in size of bulk material that may be carried. A 36-inch unit, such as is shown, is made up of six 6.00x6 tires mounted on a simple stand with the entire unit on one axis rather than offset. Goodyear does not manufacture the idler; it has developed it simply as a service to the conveyor industry and its customers.

Portable and air-powered, E. H. Wachs Company's improved pipe saw is said to cut cast iron and steel pipe from 12 to 48 inches in diameter at the rate of 2 inches a minute. The tool is driven by a motor using air at 85 psi. pressure, and is carried around the pipe by two silent-type chains which also hold it tight against the work and act as flexible ring gear for positive feed. Changes in chain length are readily made by setting front guide rollers in any of a number of holes in the main frame, while tension and depth of cut are each adjusted by a single screw. According

to the manufacturer, the saw can be set up by two men in about fifteen minutes and completes a clean cut with milled edges in one rotation. When used above ground, the pipe is rolled on skids; but in a trench the tool needs 14 inches clearance. Being air-operated and of sealed construction it works underwater. The saw is especially recommended for cutting gas and petroleum lines where flames are to be avoided.

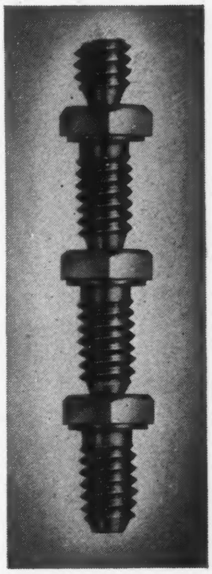
Designed primarily for silencing compressed air discharged from pneumatic equipment, the Atomuffler, recently announced by Allied Witan Company, can also be used on the intake end of a compressor for both muffling the noise and filtering the air to a minimum degree. The exhausted air enters an expansion chamber which is so patterned as to break it up into conflicting streams which create opposing sound waves that equalize one another. The air then flows through a fibrous disseminator and emerges in a series of radial planes free of restriction and objectionable noise. It is



claimed that the decible reading of compressed air passed through the Atomuffler is approximately 35, as compared with 110 when it is exhausted directly into the atmosphere. Back pressure developed per pound of air-line pressure at 150 psi. is 0.066. The unit is said to perform satisfactorily at pressures exceeding 300 psi. and is made in pipe sizes ranging from 1/8 inch to 2 inches. The 3/8-inch Model 00 is about 5 inches long and has a diameter of 2 3/8 inches.

Described as a "metal roof that spreads on," Fiberated Lumiclad is a creamy fluid in which fine asbestos fibers with adhering aluminum flakes are held in suspension. The latter give the compound its characteristic silver color which reflects the sun's rays, while the asbestos adds insulating properties, a combination that is said to lower the inside temperature as much as 20 degrees. Application is by brush or power spray, a gallon covering from 100 to 200 square feet, depending upon the porosity of the roofing material. Lumiclad is made by the Abesto Manufacturing Company.

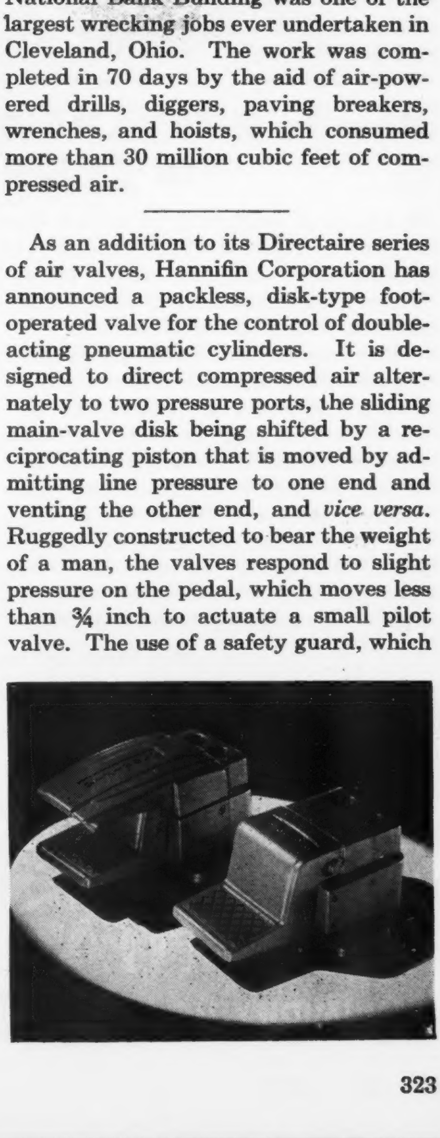
Screwsticks, as they are aptly named, consist of a series of identical precision screws joined head end to screw end by a metal neck that is varied to meet the user's requirements. A product of the American Screw Company, the sticks are driven and fed automatically by a spiral, hand-ratchet, electric, or pneumatic tool, any one of which is said to insure uniform tightening. Each screw is twisted off and fastened when a predetermined torque is applied to the screw next in line. As it is



freed, its head is burnished smooth by the succeeding one, which advances. Screwsticks are now available in diameters Nos. 0 to 5 in mild steel, brass, and aluminum.

Demolition of the 19-story Central National Bank Building was one of the largest wrecking jobs ever undertaken in Cleveland, Ohio. The work was completed in 70 days by the aid of air-powered drills, diggers, paving breakers, wrenches, and hoists, which consumed more than 30 million cubic feet of compressed air.

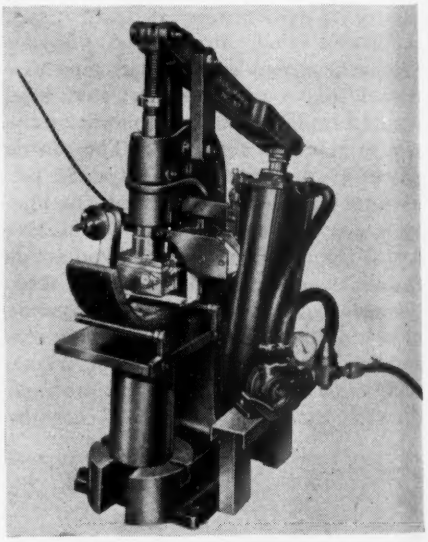
As an addition to its Directaire series of air valves, Hannifin Corporation has announced a packless, disk-type foot-operated valve for the control of double-acting pneumatic cylinders. It is designed to direct compressed air alternately to two pressure ports, the sliding main-valve disk being shifted by a reciprocating piston that is moved by admitting line pressure to one end and venting the other end, and *vice versa*. Ruggedly constructed to bear the weight of a man, the valves respond to slight pressure on the pedal, which moves less than 3/4 inch to actuate a small pilot valve. The use of a safety guard, which



extends over the pedal and minimizes the danger of unintentional operation, is optional. A unit so protected is shown in the accompanying illustration. The Model NFS is made in ½- and ¾-inch sizes and functions with air at from 25 to 150 psi.

Insect control on a large scale indoors is the object of a roller-mounted electric sprayer and hand gun which uses compressed air instead of liquefied gas as the misting agent. The insecticide is compounded of an odorless petroleum base supercharged with pyrethrum activated by piperonyl. A Gulf Oil Corporation formula and called Gulfspray Concentrate, it is nontoxic to human beings and safe for use around food. It is said to take less than half an hour to treat an enclosed space 250,000 cubic feet in volume.

Brake blocks molded of asbestos rock are extremely hard and have necessitated the development of a man-sized press in order to mark each plainly with the company trade mark and catalogue number. The machine, made by the Acromark Company, is air-powered and exerts approximately 16,000 psi. pressure. It is provided with an electrically heated die beneath which a pigment impregnated tape is fed automatically.

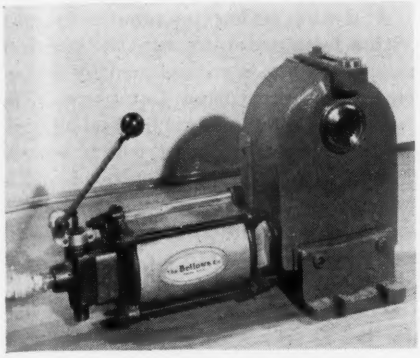


With each stroke of the press the tape advances and the color is burned deeply into the brake block, insuring markings that are said to remain clear. The press is operated by a foot valve and uses air at 80 psi., which may be taken from a shop line. The heating element can be plugged into any ordinary lighting circuit.

It may be unknown to some that a letter once mailed, even if it has left the post office, can be withdrawn from near and distant places. There is a blank available for the purpose, entitled "Sender's application for withdrawal of mail," which, together with identifica-

tion and a deposit to cover the cost of a telegram or cable to the postmaster at the point of destination, will recall the missive.

The Bellows Company has introduced a heavy-duty chuck that handles most standard collets with a stock clearance up to 1⅜ inches. Designated as the BZC-10, the unit is operated by an air cylinder and is said to have a gripping power at 60 pounds air-line pressure equal to approximately 185 foot-pounds



torque. This is sufficient to withstand severe drilling, tapping, and milling without danger of the work piece slipping or twisting. Used with an adaptor, the chuck can take well-nigh any standard externally threaded draw-type collet and permits the passage of stock with a maximum variation in diameter of 0.02 inch. An adjustable positive stop can be incorporated as optional equipment. A feature of the unit is the "dead man" safety control which gives it a firm hold even should the air pressure fail. Air pressure has to be applied before the work can be released. The chuck can be mounted in any position and does not have to be removed from the table to change collets. It is obtainable with a manually operated or electrically controlled air valve.

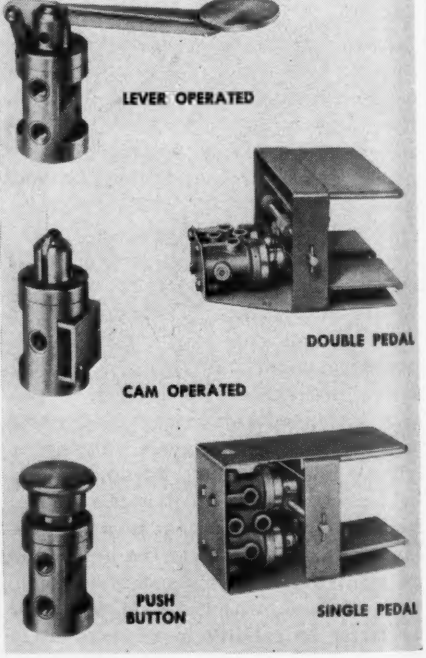
In coöperation with the Naval Boiler and Turbine Laboratory of the U.S. Naval Shipyard, Philadelphia, Pa., Marco Chemicals Incorporated has developed a novel and, it is claimed, effective method of checking new and worn machined surfaces of mechanical parts such as bearings, gears, valve seats, cylinder liners, journals, turbine blades, and boiler tubes. It involves the use of a special casting plastic that is supplied in kits containing a pint of the liquid and the right amount of a catalyst which, when combined with the resin, will cause the latter to solidify in approximately fifteen minutes. The plastic is simply poured on the part to be checked and removed when hard, providing an accurate and permanent record of its surface condition. In cases where the liquid would run off, Scotch Tape is used to form mold walls. The resin is green, because surface irregularities are easily de-

tected against the colored background, and it is said to be so sensitive that even fingerprints left on highly polished surfaces show on the castings.

Functional furniture with partitions attached to provide private or semiprivate offices in large open spaces without rebuilding has been designed by Du Pont engineers for the company's own use. The basic element is an L-shaped desk which, with a file and bookshelf added, forms a complete unit.

A double-acting pneumatic cylinder with a false piston to vary the length of the stroke has been designed by Anker-Holth Manufacturing Company. The position of the piston is changed by turning a connecting screw which extends through the near cylinder head and is provided with a threaded star wheel that serves as a lock nut. The screw is bored and threaded to admit air for movement in one direction. The air connection at the other end is in the side of the cylinder head. Seals carried by the piston prevent air from reaching the unused section.

Shown in the accompanying illustration is a new line of pilot valves introduced by Hanna Engineering Works for the direct control of small air cylinders and, through the aid of Hanna Mastair valves, for the automatic control of large units. Four types are available: lever-, cam-, and pushbutton-operated



3-way valves and a 4-way foot valve with either one or two pedals. The former provides semiautomatic control and the other full cylinder control in both directions. The cam-operated unit features a spring-loaded roller that can be operated by a straight-line or rotary

cam. Like the handle of the lever type, the roller can be rotated 90°. The push-button valve is compact and therefore well suited for panel installation.

Sheet-metal nuts in continuous strips solve the problem of holding the bits of metal during assembly operations. As soon as one is secured it is broken off and the next one applied. Named Tandem, the strips are made by Tinnerman Products, Inc., and so far are available only in the company's Speed Nut No. 10-24 Size.

Heavy canvas tarpaulins, commonly used by linemen when working atop telephone or power-system poles in bad weather, are being discarded for light-weight plastic coverings that do not shut out the light and keep them dry in rain, sleet, or snow. An added advantage is that they will not rot if folded when wet. Made of vinyl sheeting, the new tarpaulins range in size from 4x6 to 20x24 feet.

Self-sticking labels printed in black on background colors established by the American Standards Association are now available for the identification of piping systems of small diameter—¼ to 2 inches. A typical Quick-Label marker is 2¼ inches wide and 9 inches long and is mounted on a card to facilitate storing and handling. It may be cut into shorter lengths because the designating name is repeated eighteen times. Along one edge is a starter strip which, when pulled, releases one corner of the label, permitting it to be peeled off the backing and applied at the same time. A folder and sample marker for a small- or large-diameter pipe can be obtained free from the manufacturer, W. H. Brady Company, 815 N. Third Street, Milwaukee, Wis.

Sponsored by the Army Signal Corps, the Battelle Memorial Institute, Columbus, Ohio, has developed a copper-silver alloy that can be drawn into wire of high electrical conductivity and strength. The research was instituted because the line used by the corps for field telephone service is made of four strands of copper wire and three of steel—the former transmitting the current and the latter providing the necessary strength. This combination of metals, so dissimilar in character, causes production and installation difficulties which are overcome, it is claimed, by the new wire. More that 50 miles of it have been made for testing under actual conditions and the indications are that it can be stretched for long distances without breaking, that it is easy to handle, and that it is a better conductor than the older type. Among other applications suggested for the copper-silver alloy are radio, television, and instrument manufacture.

Industrial Literature

Instruments for flow-rate measurement and for automatic control of flow are described in Catalogue 50 published for free distribution by Fischer & Porter Company, 50 County Line Road, Hatboro, Pa. Instruments covered include variable-area primary flow meters, frictionless series-resonant circuit electrical transmitters, flow-rate recorders and controllers, ratio controllers, totalizers, batch control systems, and direct-connected recorders, controllers, and pneumatic transmitters. Also discussed are air-operated control mechanisms and air-operated diaphragm motor valves. Specifications, capacities, and construction details are given for all the instruments.

The Sheffield Corporation has published a new catalogue descriptive of its dial-type air-operated Precisionaire, an instrument for gauging the dimensions of a wide variety of industrial products in production-line operations. The dead-stop action of the indicator arrow, and the quick response of the latter to changes in air flow at the gauging jets when a part is moved at high speed into checking position, make it well-nigh impossible, it is claimed, for the operator to take inaccurate readings. The instrument is constructed to withstand the hard service and abuse normally associated with production-line gauging. Copies of the bulletin will be sent upon request addressed to the company at Dayton 1, Ohio.

Electric Machinery Manufacturing Company, Minneapolis 13, Minn., will send upon request a copy of its Bulletin 2200-PRD-196 which tells in nontechnical language what to look for when ordering generators. Construction features are dealt with, and recent installations of large, slow-speed engine-type units are illustrated and described. Also available is Booklet No. 194 which covers switchgear for single and parallel generator installations at voltages from 120 to 5000. Structural details, specifications, and connection diagrams are given for generator, synchronizing, feeder, and distribution panels; and installation views in utility and industrial power plants are shown.

R-S Products Corporation, Wayne Junction, Philadelphia 44, Pa., will send to interested persons copies of two new bulletins. One, a 12-page catalogue, describes its new line of 50-pound valves designed especially for rugged hydraulic service. They are of the narrow, face-to-face type and are available with different types of stuffing boxes. Provided with rubber valve seats, they are said to give bubble-tight shutoff up to 80 psi. with air and commercially tight shutoff at 100 psi. with water. The second bulletin features four models of a compact shock-absorbing device that eliminates shock and hammering in pipe lines carrying water or petroleum products. Typical applications and installation instructions are included in the publication.

E. F. Houghton & Company has published a 6-page folder describing Houghto-Solv, a fuel-oil additive which dissolves sludge in storage tanks and other parts of oil-burning heating systems. The substance is claimed to be fast-acting, to improve the efficiency of heating plants, and to eliminate costly cleaning jobs by making the sludge burnable with the oil. Houghto-Solv "W," an additive for emulsifying free water found in fuel-oil systems, is also discussed. Besides the folder on additives, the company has prepared an 8-page booklet on its line of rust preventives that gives the physical properties and characteristics of each compound, as well as operational data such as type and thickness of film, amount of coverage obtained, etc. Copies of both publications may be obtained from the company at 303 West Lehigh Avenue, Philadelphia 33, Pa.

Safety apparatus for industrial application is discussed in a 64-page catalogue obtainable from Willson Products, Inc., Reading, Pa. In addition to describing the company's line of eye and respiratory equipment, the publication contains much technical and reference material intended to aid users in selecting the proper type and style for each specific occupational hazard and to give helpful information on its care. Among the subjects discussed are performance tests for heat-treated glass; the advantages and proper use of plastics in the industrial-safety field; kinds of filter glass available for service where varying degrees of glare and radiant energy are encountered; respiratory hazards; and gases and vapors prevalent in industry, with recommendations as to the proper gas-mask and canister assemblies for specific contaminants.

A new type of air valve for air cylinders is described in a bulletin recently issued by The Beckett-Harcum Company. Termed Hi-Cyclic, it is said to control the stroke within 0.001 inch, to stop and then return the stroke at any point without overtravel, to regulate the speed of the stroke in either direction, to reciprocate either mechanically or electrically, to control the pressure in both ends of the cylinder, and to effect a considerable saving in air consumption. Operational data, construction features, illustrations, and engineering drawings of the models are given in the bulletin, a copy of which may be obtained without charge by writing to the company at 1140 Wayne Road, Wilmington, Ohio.

How to choose lighting systems and equipment for industrial plants is the subject of a bulletin made available by Benjamin Electric Manufacturing Company, Des Plaines, Ill., primarily for architects, electrical contractors, lighting specialists, and others charged with the responsibility of planning such systems. It features two charts: one dealing with the application of each of the company's twelve major lighting systems, which include practically every job having illumination requirements between 10 and 150 foot-candles, and the other covering special units for installation in dusty, damp, or combustible atmospheres. The bulletin also points out what to look for when appraising lighting equipment and the benefits that are to be obtained through proper illumination.

Axle assemblies for industrial use are the subject of Catalog No. 101 of The United Manufacturing Company, 76 West Interstate Street, Bedford, Ohio. Available in either 2- or 4-wheel units, with capacities up to 6000 pounds and 12,000 pounds, respectively, they are suitable for transporting generators, pumps, tar kettles, concrete mixers, fire-fighting equipment, cable reels, power and telephone poles, public-utility service equipment, etc. Special sections describe mounting brackets, hand brakes, automatic hydraulic brake controls, spindles, hitching devices, and other accessories, as well as standard and de luxe all-purpose running gear, in capacities up to 7000 pounds, furnished complete with automotive-type steering, solid-beam axles, Timken tapered roller bearings, and adjustable stakes and reach.

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